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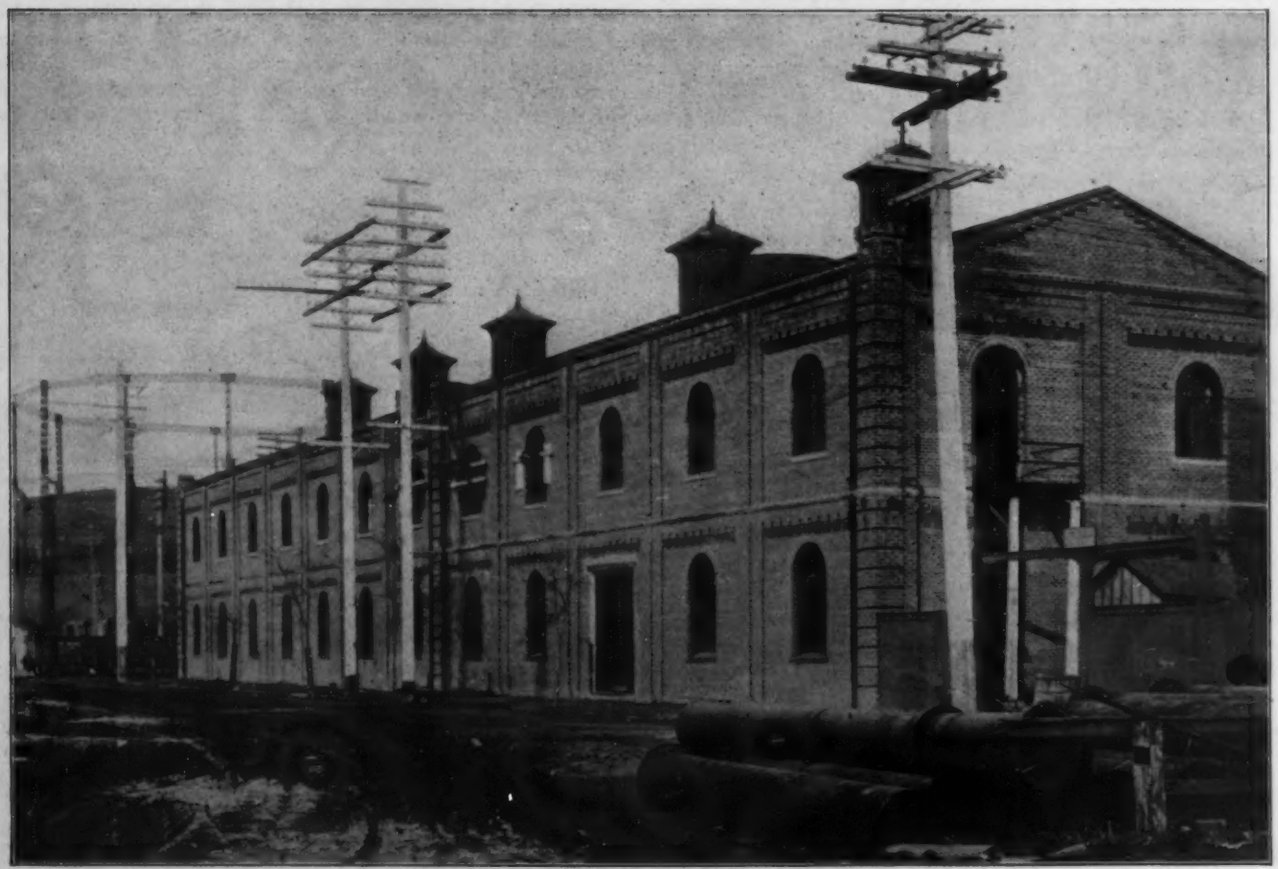
VOLUME XVIII. SAN FRANCISCO, CAL., MARCH 16, 1907 No. 11

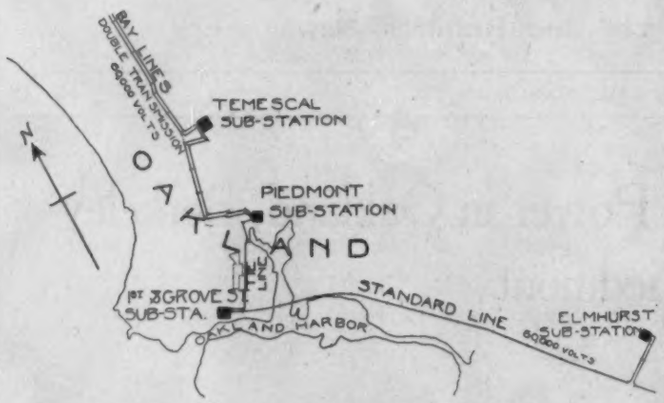
The Distribution of Electric Power in Oakland, Berkeley and Piedmont

In common with many towns and cities situated near San Francisco Bay, Oakland, Berkeley and Piedmont, which, though politically separate, are virtually parts of a single city of about 250,000 inhabitants, receive the greater part of the electrical energy which they consume over the long-transmission lines running from the western slopes of the Sierra Nevada Mountains. The standard line of the California Gas and Electric Corporation, which transmits from the hydro-electric station at Electra, in Amador County, about 175 miles distant, enters the City of Oakland from the southeast, after passing through the sub-station at Elmhurst. This is shown in the accompanying sketch. The double bay line of the same corporation, commonly known as the Bay Counties Line, comes in direct from the south tower of the suspension across the Carquinez Straits, over which the wires hang between supporting towers 4,427 feet apart. This line is fed by the station at Colgate, in Yuba County, about 141 miles distant, and the De Sablo station, in Butte County, about 190 miles from Oakland. By means of the "Tie Line," shown in the sketch, the Standard line and the two Bay Lines, may be operated in parallel, as is frequently done; or, should one of the lines be out of order, the sub-stations can operate from the other two. Power from all three lines is received at 60,000 volts.



MAIN BUILDING, FIRST AND GROVE SUB-STATION, AND ONE OF THE GAS HOLDERS OF THE OAKLAND GAS, LIGHT AND HEAT COMPANY

The largest of the sub-stations is at the corner of First and Grove streets, being operated in connection with the auxiliary steam plant of the Oakland Gas, Light and Heat Co.



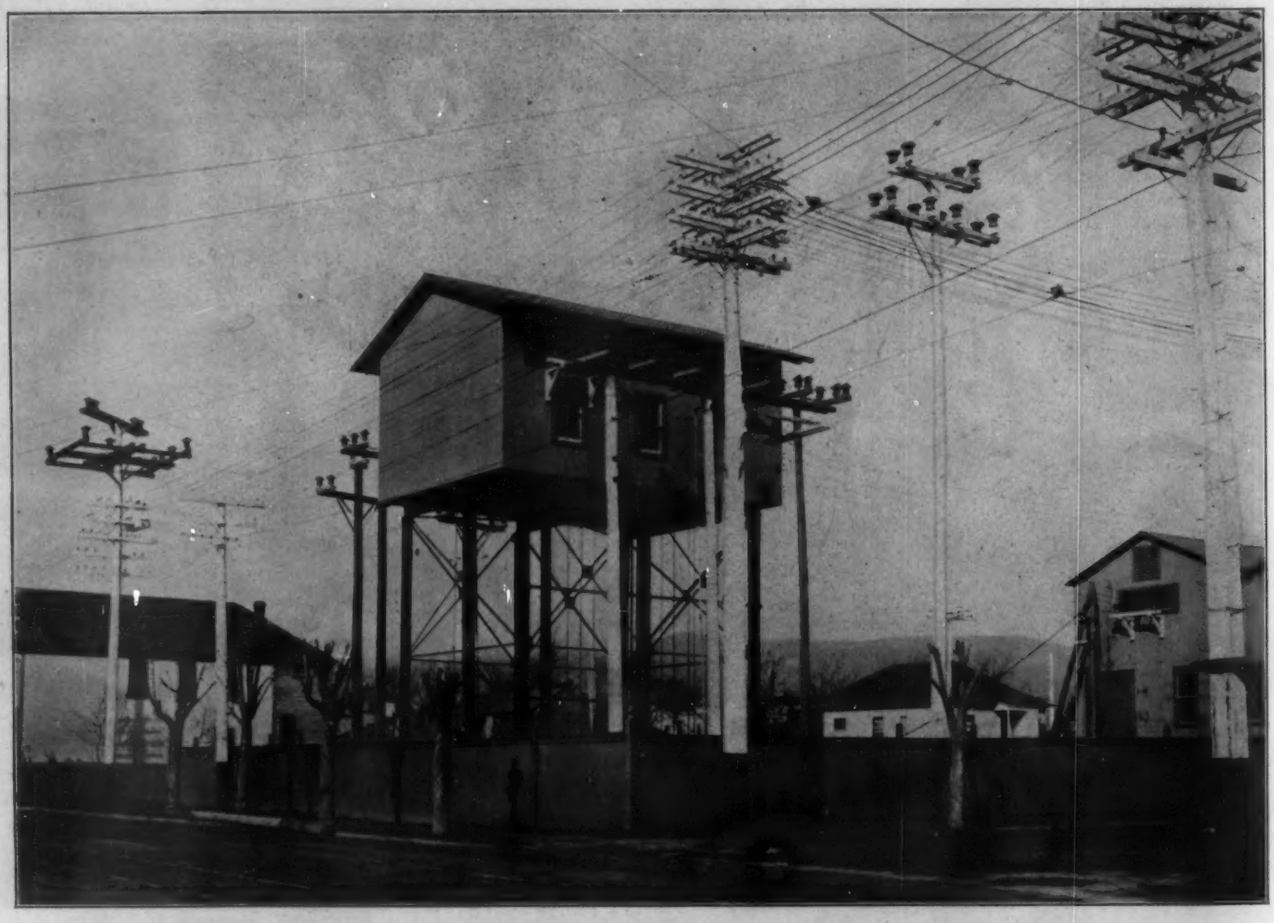
STANDARD AND BAY COUNTIES LINES AS THEY ENTER OAKLAND SHOWING TIE LINES

This plant, running continuously, takes care of the excess of the load over the capacity of the various transmission lines. Steam is generated by two batteries of return-flue, tubular boilers at 110 pounds pressure without superheat and by four Altman-Taylor boilers placed in sets of two. These have superheaters and supply steam at 150 pounds, with a normal rating of 250 horsepower each. The furnaces, of course, are all oil-burning. The fuel oil is stored in a riveted steel tank having a capacity of 5,000 barrels. This tank is placed entirely above ground, and the oil runs by gravity to the pumps, which belong to the Snow oil pumping system. By-passes are provided around the pumps so that if the oil is warm enough to flow it is possible to feed the boiler furnaces by gravity.

The engine equipment consists of a large Ballwood-Corliss vertical, cross-compound engine, direct-connected to a 750-kilowatt alternator. The cylinder dimensions are twenty-one and one-half inches and forty-five and one-half inches by twenty-four-inch stroke, with pressure in the receiver averaging about twenty pounds gauge. In addition to the above there is a McIntosh & Seymour 400-horsepower engine and a Hamilton Corliss of 500-kilowatt capacity. This latter is a horizontal tandem compound, twenty-two by forty-eight by forty-eight inches.

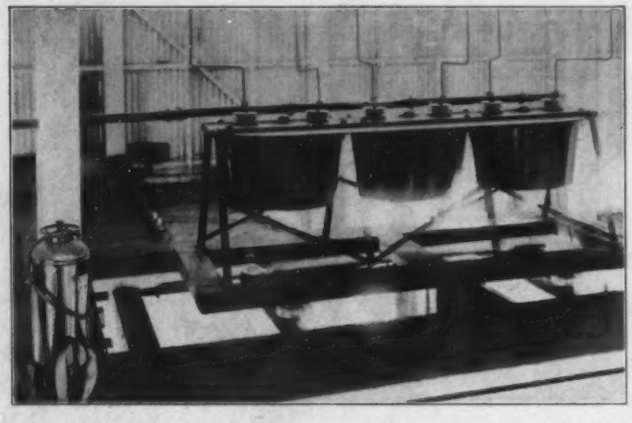
The system of lubrication is entirely automatic. The oil passes through a filter into a receiving tank from which it is pumped to separate gravity tanks for each engine. From these the oil flows through the bearings into another tank from which it is repumped to the filter and again sent through the same cycle. Two Worthington duplex, three by two by three-inch pumps operate this lubricating system, one pumping from the receiving tank to the gravity tanks and the other back to the filter.

The engines are all run condensing, as plenty of cooling water for the condensers is available, the plant being located in proximity to the Oakland estuary, an arm of the San Francisco Bay. When the tide is low, however, water can not be readily obtained without extending the suction pipe a considerable distance. To avoid this a system of storage has been devised. A large reservoir capable of holding about 1,250,000 gallons, has been constructed by enclosing a portion of the beach with wooden bulkheads. From these eight and



HIGH-TENSION SWITCHING TOWER, TEMESCAL SUB-STATION, SHOWING THE EXTERIOR AIR-BREAK SWITCHES.

ten-inch pipes run to the condensers, which are about 500 feet from the intake. By means of a number of gate valves water may be taken through the same pipes, either from the reservoirs or from the bay, as desired. On account of the large quantity of circulating water required, it is necessary to discharge back into the reservoirs, during low tide, where the water becomes cool again to a certain extent. As soon



ONE OF THE HIGH-TENSION OIL SWITCHES IN THE TRANSFORMER HOUSE, FIRST AND GROVE SUB-STATION.

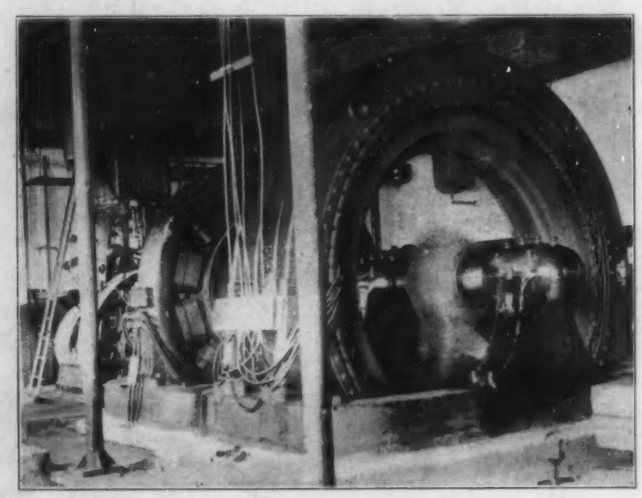
as the tide-water is high enough, however, the suction is changed from the reservoirs to the bay. The reservoir gates are opened, the warm water runs out, and the reservoirs are refilled by the incoming tide.

The water in the supply pipes is prevented from running out when the condenser pumps are stopped, by automatic foot valves. The end piece of each of the intake pipes is fitted in a stuffing box with a swivel joint, and is raised for cleaning by a chain and windlass.

The condensed steam from the surface condensers is pumped to the hot-well through trays of excelsior which catch the oil. The feed water is supplied from a fourteen-inch well 180 feet deep, the water being pumped by a Thomson and Evans deep-well pump.

Power is generated in this station at 2,300 volts, three-phase, by several large alternators either direct-connected to the prime movers mentioned above, or belted in some cases.

The distributing switch boards, three in number, are located on the second floor of the main building. There are twenty-seven panels in all, with all necessary recording and integrating instruments. The regulation of the distributing circuits is accomplished by seven General Electric hand regulators.



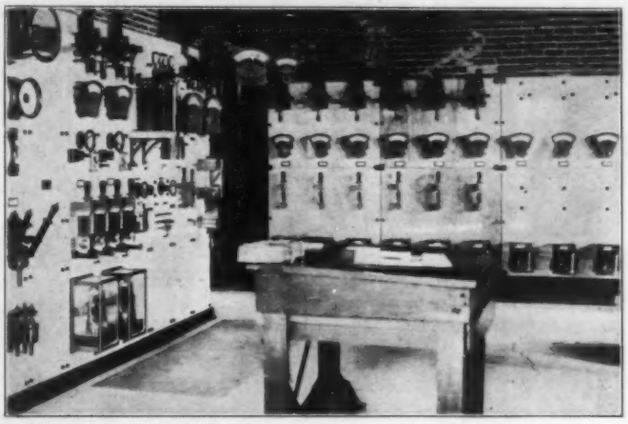
870 KILOWATT MOTOR-GENERATOR SET, FIRST AND GROVE STREETS SUB-STATION

On the same floor are also the constant-current transformers, the primaries being connected to 2,300-volt circuits. There are three 50-light and two 100-light oil-cooled regulating transformers, and four 50-light, air-cooled transformers.

The sub-station equipment connected with this plant is in a separate brick building adjoining the main station. A corrugated iron building is used exclusively for the high-tension transformers and oil switches. The air-break switches are situated outside of the building near the entry in accordance with the usual practice. Within the building, supported by a wooden gallery, are three sets of oil switches for controlling the Standard line, the Bay line and the two lines connected in parallel. The switches are operated from the main floor by hand levers.

The voltage is stepped down from 60,000 to 2,300 and 4,000 by six 1,000 kilowatt Stanley oil and water cooled transformers, one set being Y-connected and the other delta. In addition there are four similar transformers connected open delta for stepping up from 2,300 to 10,000 volts for transmission to large consumers situated some distance away.

In the main building are several synchronous motor-generator sets for producing continuous current at 575 volts for street railway and for elevator and general power work. The largest of these, a Stanley 870-kilowatt unit, was installed last May. The synchronous motor is a three-phase machine of the inductor type and operates at 2,300 volts. The con-



CORNER OF THE TEMESCAL SUB-STATION, SHOWING SEVERAL OF THE SWITCHBOARD PANELS.

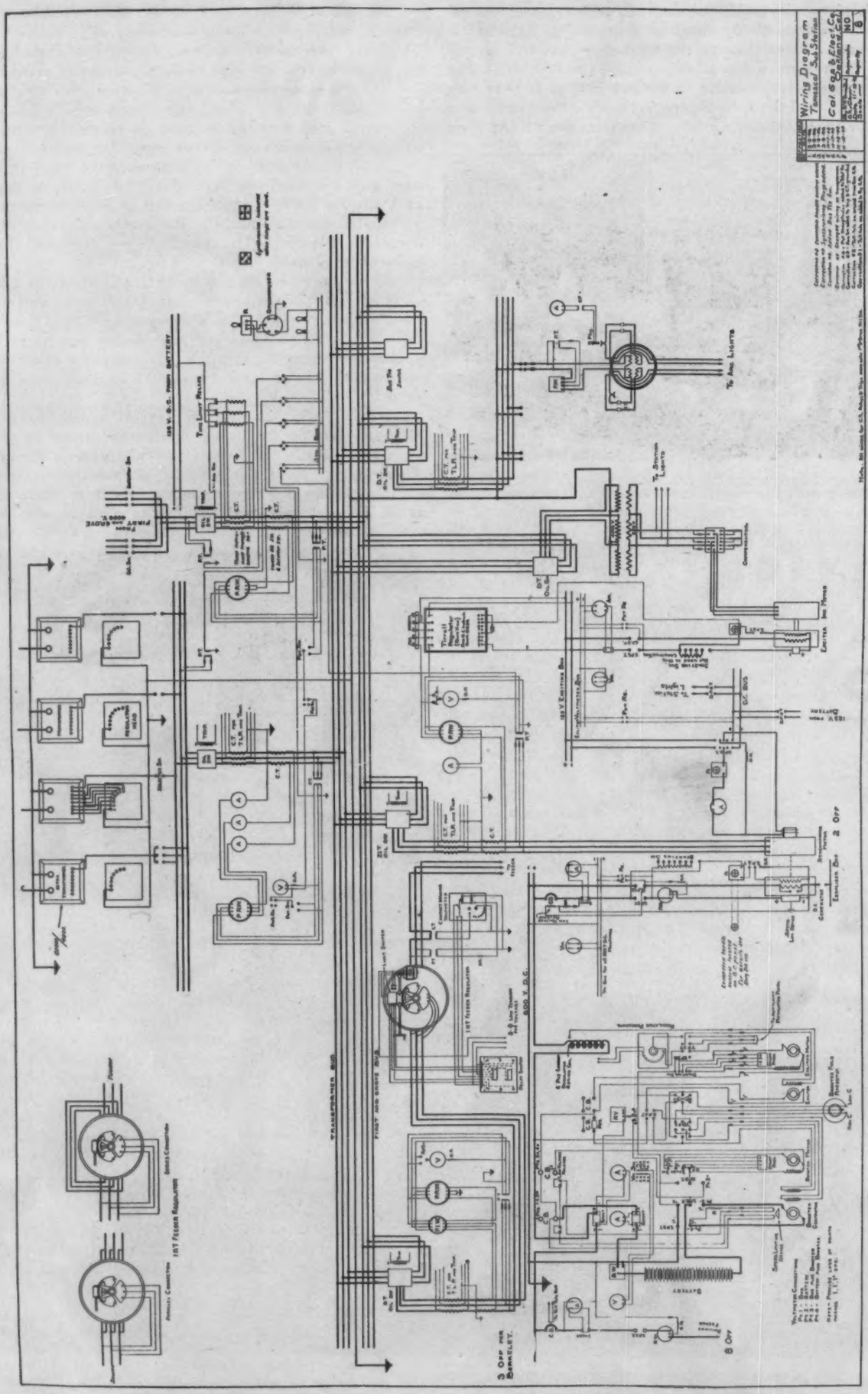
tinuous current generator is a 12-pole machine, direct connected thereto.

This station supplies South, Central and East Oakland, including the principal business district.

Berkeley, North Oakland, Piedmont and an emergency line to Point Richmond, which connects with the plant of the Standard Oil Company, and is to be used for fire purposes only, are supplied from the Temescal sub-station, situated on Fifty-first Street, near Telegraph Avenue. Several of the street car lines of the Oakland Traction Consolidated are also operated by power from this station. The building is of brick and corrugated iron, with large windows, which afford excellent light and ventilation. The eastern half of the building has but one story and is now used for the accommodation of the storage battery cells.

The western half, which consists of the sub-station proper, was built about a year ago and consists of the transformer and generator rooms. This floor is built over a high basement, which provides for all wiring and piping. The building of brick with concrete steel floors throughout. These floors are designed for a uniform load of 9,000 pounds per square foot.

The high tension transformers are 1,000 kilowatts each and are water cooled, each transformer being piped so as


Wiring Diagram
Temescal Sub Station
Cal Gas & Elect Co
Oakland Cal
To Arc Lights
To Station Lights
To Exciter Set Motors
To Exciter Set Lights
To Station Lights
To Arc

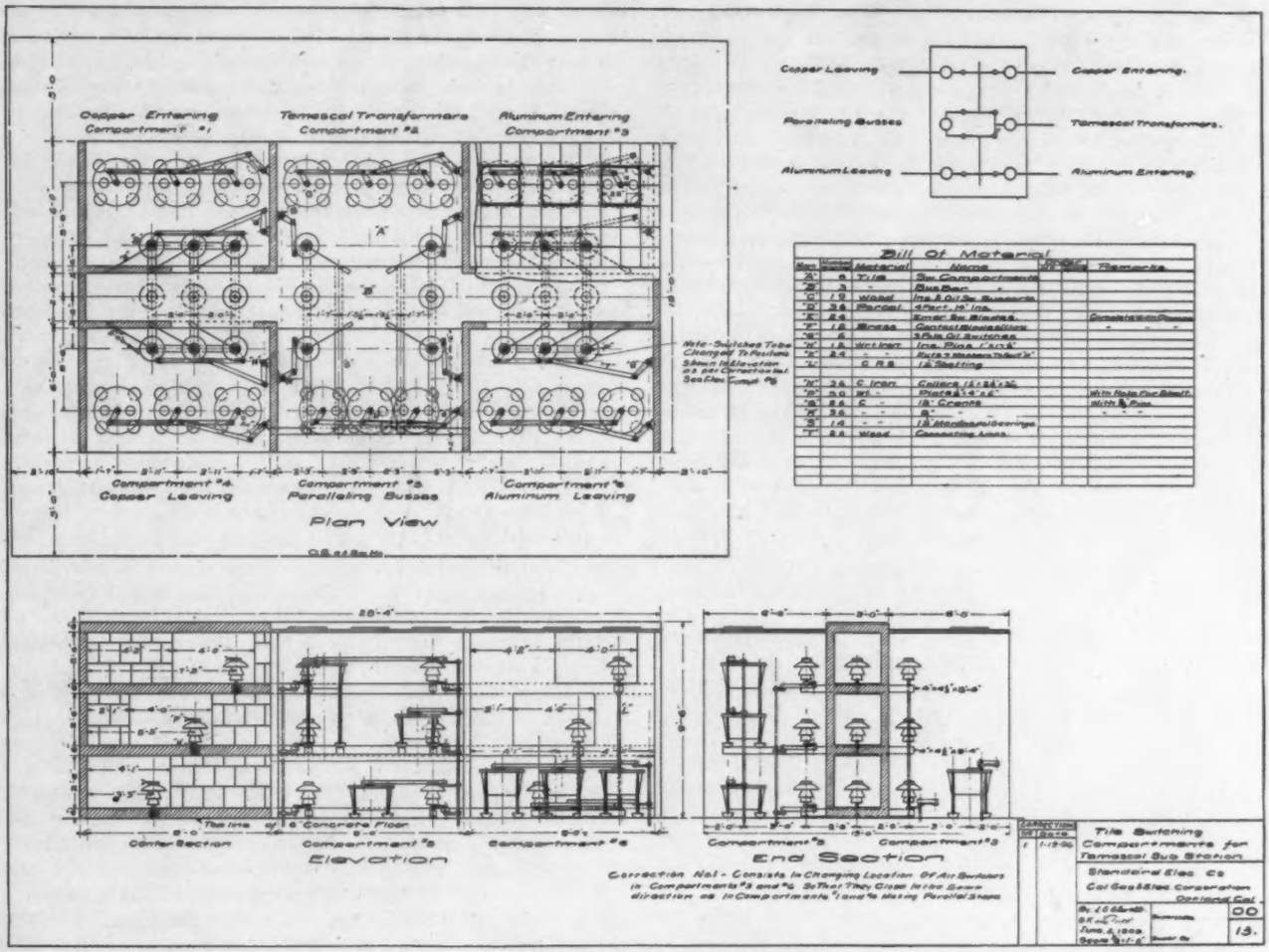


DIAGRAM OF SWITCHING TOWER.

to give independent regulation of the cooling water. Temperature gauges are placed on each transformer with an alarm attachment, which can be set to ring at any predetermined temperature. There are four transformers of this capacity, three connected in "Y," stepping the voltage down from 60,000 to 4,000 volts. The fourth is an emergency or spare transformer, being on hand and in place in case of any accident to one of the others. It has a high tension tap that can be connected to any leg of the high tension bus bars. While the secondary leads are provided with three selector switches by which it can be connected to any secondary legs. In case of accident to one of the regular transformers, service would be interrupted only long enough to make the high tension connection and to close the proper secondary switch. This arrangement is shown in the cut of the wiring diagram. Regulation is effected by means of a hand regulator head provided for each transformer with taps taken from the windings.

Between the generator room and transformer room is an 18-inch wall with opening for the doorway protected by an automatic closing, fire-proof roller door. This insures perfect isolation of a fire should one occur. The floor of the generator room is 8 inches higher than that of the transformer room as an additional fire protection to provide against oil from the transformers, possibly flowing into the generator room.

The equipment of the generator room consists of motor-generators, switchboards, etc., as shown in the acompanying illustrations. There are two 450-kilowatt motor generators of General Electric design. The motor is of synchronous revolving field type with stationary armature, wound for 2,300 volts delta, or 4,000 volts star, and designed for 60 cycles. The speed is 400 revolutions per minute. The generator supplies direct current for the street railway service at 575 volts. The machines are provided with automatic end play and runaway release devices, as well as low voltage release. They are guaranteed for 50 per cent overload for two hours without undue heating. An interesting feature is

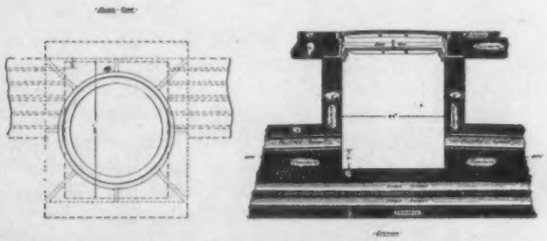


DIAGRAM OF HAND HOLE UNDERGROUND SYSTEM.

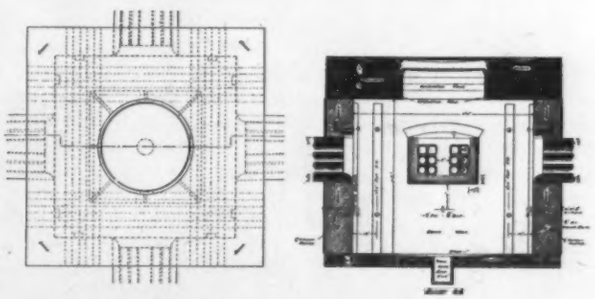


DIAGRAM OF MANHOLE UNDERGROUND SYSTEM.

the speed control arrangement used in starting. The direct current end of the motor generator is run as a motor, current for which is supplied by the storage battery set. The speed of the motor is varied by means of the field rheostat located on the direct current panel some twenty feet away from the alternating current panel. This renders it difficult for the attendant to throw in the alternating current circuit onto the motor at the instant synchronous speed is reached, as the varying load of a railway system causes very sudden changes of speed. To avoid this arrangement a concentric handle rheostat equipment mounted on the alternating current panel was designed. The outer handle controls the field of the alternating current motor. The inner handle controls a small rheostat in series with the main rheostat of the direct current field. Thus, in starting it is possible for the attendant to close the switches on the direct current panel, and regulate the speed to about synchronous speed, then go to the alternating current panel and there do the final adjusting, closing the switch when the synchronizer shows synchronous speed.

In connection with the railway supply a storage battery of the Electric Storage Battery Company's Type G 41 is used, containing 276 cells, its maximum ampere capacity being 1,600 amperes. This battery, in connection with the carbon regulator and booster, give excellent regulation on the direct current lines. The method of regulating is as follows: The load of the machines is adjusted for a certain amount, and by an automatic device the batteries take care of all fluctuations, discharging during peak loads and charging when the machines are underloaded. The carbon regulator is made up of a number of carbon discs which form a variable resistance. This resistance is used in connection with pilot cells to vary the exciting current for the fields of the booster. These carbon discs are subject to slight mechanical changes in pressure produced by a plunger suspended in a coil carrying the current to the combined generators. This change in pressure necessarily varies the resistance of the carbon piles and thus affects the exciting current of the booster. T. A. Regulators are used, in addition, on the field of the generators.

The switchboard, made of blue marble, consists of a totaling panel, two motor generator alternating current, and three alternating current lighting and power panels on the alternating end. The direct current end comprises an exciter panel, two direct current generator panels, a four-piece battery panel and eight railway feeder panels. All oil switches, bus bars, instrument transformers, etc., are located in the basement, the oil switches controlled of course by handles extending up to the board.

No high tension wires are brought to the board, but are controlled entirely by means of remote controlled switches located in a separate switching tower, as shown by the illustration. The building is constructed of reinforced concrete, with steel supports. The outer shell is of corrugated iron. The switching compartments are fire-resisting, the floor being of reinforced concrete, and the walls and top being of hollow tile. The interior is divided into six compartments, 6x6 feet, and 9 feet high.

The arrangement of compartments and method of switching are shown in the accompanying diagram. Two sets of air break switches are arranged outside near the entry and exit to the tower. Within are six sets of oil and six sets of air break switches so connected as to permit operation from either of the transmission lines or from both connected in parallel. By means of a series of levers carried to the station floor, the operator can readily control any of the switches by manipulating a hand lever. The controlling arrangement is very similar to the mechanism used for the operation of railroad switches from a tower. The system is interlocking, and a working model of the switches is shown in front of the lever handles. These show at a glance the status of every switch in the tower. Before the operating handle can be moved a trip must be released, the act of releasing this lights a small pilot light mounted on a miniature switch. The lamp now stays lit during the actual movement of switching, and when the trip drops into the closed position the light goes out, the miniature switch showing by position what has been done.

The air and oil compartments in the tower are provided with a safety interlocking device whereby the attendant must close the air switch before he can close the oil switch, and likewise open the oil switch before the air switch. In emergency, however, if for any reason it is necessary to reverse the operation, the interlocking device can be released and the switches opened irrespective of one another's open or closed position.

The Piedmont sub-station, which is located at the corner of 24th Street and Oakland Avenue, is used exclusively for supplying power for the operation of the street car lines in the central part of Oakland. The equipment includes three General Electric 500-kilowatt step-down transformers, and three General Electric synchronous motor-generator sets of 400-kilowatt capacity each. There is no storage battery at this station.

From the sub-stations the electric power is distributed to the consumers by the Oakland Gas, Light and Heat Co., a local organization controlled by the California Gas and Electric Corporation. The older practice was to run single-phase, 2,300-volt primary circuits. There are ten such circuits supplying at present about 5,000 kilowatts to the greater part of Oakland. The new system of distribution employs three-phase, 4,000-volt, four-wire circuits, the transformers being Y connected, giving a pressure of 2,300 volts between one wire and the neutral. The secondary distribution is three-wire, 440 volts, between outside wires, and 220 between outside and neutral. This has proved very satisfactory to the company, and as only two service wires with not over 220 volts are taken into the houses, the fire hazard has not been found to be any greater than with 110 volts, especially as the company maintains a very rigid inspection of all their customer's wiring.

Berkeley is supplied by two 4,000-volt, four-wire primary circuits, and North Oakland at present by one. The company contemplates running another circuit to Idora Park, which will also supply a portion of North Oakland.

From the First and Grove-Street sub-station, one three-phase, three-wire, 4,000-volt power circuit runs to East Oakland, one to West Oakland, and one to the Temescal sub-station. This latter acts as a tie line.

The business district of Oakland is covered by a network of power circuits fed by two direct current feeders at 500 volts. In the districts supplied by single-phase circuits, taps are taken from an adjacent phase to form a three-phase power circuit when such is not required for heavy work.

About 900 arc lamps are used to light the streets in the residence and minor business districts. The main business district traversed by Washington and Broadway Streets is lighted by three-globe electroliers placed six in a block by contract with the city government, in addition to those maintained by the merchants.

The Oakland Gas, Light and Heat Co. is at present laying a system of conduits in the central part of Oakland in accordance with the requirements of the city ordinances. The system in general is similar to those installed in other cities, but the introduction of several minor new features and the employment of a better class of material and labor will, it is claimed, give the city of Oakland a much superior underground system than is usually found in other cities.

Eighteen-inch clay ducts are used. Their arrangement, together with the most important details of the conduit system, are well shown in the two accompanying sketches of a typical man-hole and a hand-hole. The covers of the former are 36 inches in diameter, and of the latter, 28 inches. A man-hole is constructed at every street crossing, one or two

hand-holes being placed between. Provision for the natural drainage of the ducts is made by laying the ducts on a grade of about 3 inches in 100 feet, running alternately upwards and downwards between man-holes. Four men can normally lay in a day about 100 feet of conduit having twelve ducts.

Galvanized iron service pipes will be run from the man and hand-holes into the basements of the various buildings to a specially designed service box from which circuits will run to the different meters in the same building. The underground system will be operated on 4,000-volt, three-phase, four-wire circuits, and the service transformers, which will be of the subway type, will be placed in the man-holes. It will also include the placing underground of all direct current power wires.

CHOICE OF APPARATUS AND APPLIANCES.

Mr. J. D. Ross.

In choosing my subject for tonight I have attempted to make a few suggestions on the materials used in station work which might be useful to students of this University who may be considering that branch of engineering which deals with power and light.

The whole ground has been gone over so often that my subject tonight is necessarily scattered if I would present any new ideas.

My topic suggested itself from the fact that different types and makes of apparatus along the same line differ so widely that smooth running in a plant and continuity of service are only gotten by careful selection. I wish also to emphasize the fact that the elimination of danger to human life in a plant depends mostly on the judgment shown in its design. It is a noticeable fact that there has been a wonderful advance in the invention of electrical apparatus, but a comparatively small advance in ideas and inventions for the protection of human life. We are careful to space our wires to prevent them from shortcircuiting and to insulate them from our rack to prevent a ground, but we leave bus bars and switch terminals bare or bring 2,300 volts to our switchboard and ask a jury where negligence ends and accident begins. The careful selection and installation of apparatus of dangerous voltages is no small responsibility to place on any one's shoulders, but there seem to be but few who thoroughly realize this fact, and are willing to slightly increase first cost where necessary to save human life.

Following are some points which we have found important:

Switches.

Switches should be designed more liberally between live parts and ground for a high tension plant than for one having on transmission line. Lightning arresters on the low tension side help matters considerably, but are not always reliable for protecting from static effects. We have had several switches disabled by a line grounding somewhere in the city distribution system. In these cases the circuit was completed by the current arcing from a contact or terminal to a bolt in the switch tank, thereby grounding through the iron switch frame.

A switch for 2,000 volts that does not allow "of oil between any live part and its tank or frame," and "creepage surface on its terminal insulator" should be rejected.

EDITOR'S NOTE.

This is the first of a series of lectures of the same nature as the five previous ones by Mr. Allen, which we have published in the "Journal."

These articles, by Mr. Ross, who is chief electrical engineer of the Seattle Municipal Electric Light and Power System, will cover the general subject of central station practice, and will prove of great value to all our readers.

Creepage surface should be unnecessary in the ideal switch up to 13,000 volts, as the leads can easily be insulated and carried below the surface of the oil, all connections and bare parts being below oil. It is possible to so install a switch of this voltage, on a grounded frame, that it is almost absolutely "fireproof."

I am at present designing a rack for switches and regulators which I will describe to you under the heading of "Switchboards," on the evening of February 13th. In designing this I have entirely done away with bare parts or terminals in all switches, regulators and bus bars, and have also made it possible to remove any part for repair without disturbing the service on any circuit or bus bar, and without making it necessary to work on any wire alive.

As to the selection of switch control I prefer electric as being the most flexible.

Mechanical control is probably best in small plants, but in a large plant the cost and size of switchboard becomes excessive, and all switches, rheostats or regulators become massed in one place, making it difficult and dangerous to workmen, and often dangerous to apparatus if a switch shortcircuits or other trouble occurs. In this way whole boards have been ruined.

We have tried closed circuit electric control with solenoid at 125 volts and are dissatisfied with it. A single-coil solenoid is too expensive for obvious reasons, and one with several coils requires successive contacts which have given us trouble.

We have finally decided that open circuit electric control using two solenoids on 125 or 250 volts D. C. is the most satisfactory all around switch, one solenoid closes and one opens the switch from a double push button on the board. The overload relay in this case, if used, closes a break in the control circuit, in multiple, with the button for opening the switch.

Regulators.

It is quite practicable to regulate individual lighting circuits automatically and so prevent many complaints from customers from flickering lamps due to changing load. It is almost impossible for an operator to maintain anywhere near the ideal regulation at the end of a long feeder, especially if he may have a number to control. It is customary to increase the voltage as the amperes increase, and if the amperes suddenly change at times on each circuit, it is impossible for an operator to maintain regulation.

We are at present installing six regulators, four of which are of G. E. make, type B. R., and are made automatic by a contact making voltmeter, which is a relay closing at a predetermined voltage by means of a shunt coil, and also a series coil to compensate for variations of current, both coils being connected in the branch circuit being regulated. This relay closes and opens a small direct current circuit which moves the regulator head in one direction or the other. If fluctuations are rapid the moving parts of the regulator should be as light as possible, to be free from inertia, and for this reason we have chosen a regulator with moving contacts rather than the heavier induction type. However, for voltages above 2,300 the induction type would probably be the better on large circuits. We have kept our suburban circuits at 330 kilowatts, so that moving contacts under oil give very little trouble.

On alternating circuits the best regulation can only be got by single-phase regulators, as with the exception of motor loads the phases are nearly always unbalanced and with a polyphase regulator, the regulation of one phase is not confined to it alone.

Lightning Arresters.

So much has been wirtten on lightning arresters that I shall say little about them. The ideal arrester, one possessing the proper strength and durability "under fire," and one

which insulates for line voltage at all times but allows the excess voltage to go easily to earth, seems to be still a dream of the future, where high tension apparatus is to be protected. For low tension there are several excellent arresters.

For our 45,000-volt line we use the horn type or "Dutchman" arrester, using two gaps in series with a water resistance connected to earth. This resistance is made from a 2-inch fibre conduit, 30 feet long, supported vertically by cross-arm 7 feet apart down the pole. The terminal of the second gap dips into the top of this tube, while the bottom rests on the ground and is corked with a wooden ply through which an iron pipe enters. Water is turned into this until the water flows over the top enough to wash off all dust. In frosty weather more water may be allowed to flow to prevent freezing. The size and length of this tube is calculated from the measured resistance of Cedar River water and by dipping the wire at the top further into the water any desired resistance may be obtained.

Wire.

In choosing wire for inside station construction we have made several experiments on the various types of insulation, and use the following 600-volt rubber-covered for all potential and series transformer secondaries to instruments, both for open work and in conduit. In every case we ground one side of the transformer circuit, both at the transformer and at the switchboard. All lighting and motor circuits of 110 to 500 volts are, of course, operated on this grade of wire, 3,000-volt rubber-covered for all 2,200-volt work either open or in conduit. Sizes from No. 8 up have an additional layer of asbestos. All bus bars and taps from bus bars to switches being less protected in case of short circuit or arcs are given a heavy taping of asbestos cut in strips and soaked in sodium silicate solution. An outside wrapping of empire cloth holds this in place until it dries. When thoroughly dry we have found that an arc may start in the midst of heavy cables without spreading or causing damage except over a very small space.

Anything in the way of fire extinguishers is of necessity a failure in stopping an arc, as their object is to generate carbon dioxide and smother a flame for lack of a supply of oxygen. It is obvious, therefore, that an arc which does not depend on combustion is not affected but rather helped by the chemical used.

The choice of thoroughly fireproof covering of high dielectric strength on all important high voltage busses or wires is of vital importance. I prefer angle iron racks for supporting all wires in stations or sub-stations. The city sugstation at Seventh and Yesler Way has not a foot of wire supported on wood from the entrance of the current at 45,000 volts to the lowest voltage feeder. Iron gas pipe or angle iron supports are neat and substantial, and if any insulation should be faulty the arc has nothing to set on fire.

For outside work it is best to use nothing smaller than No. 6 B. & S. for voltages above 500, for mechanical strength.

The matter of insulation on arc circuits has given us trouble in various parts of the city. The action of these circuits on parallel telephone lines has been considerable in many places. In an alternating series system leakage is often worse than induction. We have taken out a great many knobs and small insulators, and so bettered the system, and will probably use a 10,000-volt glass insulator. The difference between the price of such an insulator and one of the deep groove railway type is a small item considering the better service.

Transformers.

In choosing transformers for lighting and power work the average engineer of a municipal plant has his hands full. The purchase is made after calling for bids, and the cheapest bid is usually the cheapest transformer, fit only for a scrap pile. Actual tests show that the makes run all the way from 3,500 or 4,000 lines to 10,000 lines and over per square centimeter. Only a few guarantees are reliable. We have guarantees that core type transformers will bank in with shell type of different regulation, and to prove the argument to be wrong, two transformers were connected by short, heavy leads. The one with the better regulation rapidly heats. This makes an easy test as to whether new transformers will bank in on the system with existing transformers. It is best to decide on one make and type of transformers, and if satisfactory, to hold to this type at all times. The transformer chosen for motor work should be liberally designed to allow for overloads.

It is doubtful if it is economical to use less than two and one-half or more than 25 kilowatt units on the average loads in a growing city like Seattle; 25 kilowatt is an easy transformer to place on a pole or platform, and is about right in business districts for load distribution, while the 50 kilowatt size is too large, and owing to the large busses in such a district, we cannot bank in other sizes without throwing the load on the larger sized transformer.

Lamps.

Lamps, like transformers, should be of one make and type throughout, so that any part of one lamp can replace the same part in a damaged lamp in either series or multiple type.

As there are to be several lectures on switchboard and machine practice and on transmission during the next two months, I shall leave the discussion of these until later.

ELECTRICAL WORK IN CUBA.

The electrical engineer, like Alexander of historic fame, is ever on the lookout for fresh fields to conquer. Unfortunately, the known territories of the world have been already mapped out for his exploitation; and as the limits of his capacity transcend by far the boundaries of the earth, he must concentrate his efforts upon the not unprofitable task of developing the applications of electricity in the countries into which it has gained an entry. Since Cuba was released from Spanish occupation, it has remained in the public eye rather as a hotbed of political disaffection and revolution than as a land of promise for the engineer, and our manufacturers are, in consequence, apt to overlook the possibilities which it affords. This is, however, an error into which our Transatlantic cousins are not likely to fall, for, with characteristic enterprise, American electrical engineers are doing their utmost to develop a market in Cuba. Already there is a first-class electric power plant in Havana, while there are also good power plants for the operation of the electric car lines, in addition to the telegraph and telephone lines. In view of the possibilities in Cuba, it will not be amiss if we refer to an article in a recent number of the "Western Electrician," giving an interesting account of the conditions under which electrical work is carried out in that country, and which affect linemen principally, as will be seen from the following quotation: "The clay," says the writer of the article referred to, "is a sticky substance which clings to your shoes and makes traveling hard. It makes it difficult to sink a pole. You have to exert considerable pressure to get the point started. Then the first thing you know the point strikes a hard substance. There you quit, for you have contacted with the hard coral stratum which prevails just below the surface of the earth. This coral stratum causes the trees to topple over in the event of high winds, as the roots cannot get down into the ground very deep. With the fall of the trees the wires always get broken and tangled." Another cause of trouble to electric linemen in Cuba is the premature decay of wood in the ground. "Poles are rotted off very quickly. The result is that steel poles are employed quite largely. Most of these metal poles are con-

structed of series of pieces, arranged in a tripod plan, extending upwards to the required height. The base of the pole is sunk into cement Many of the wood poles are likewise cemented up at the foot, and the cement prevents decaying of the lumber. First the hole is made in the ground and then the base or foundation cement is put in. This is allowed to harden a little while, and then the base of the pole is put in. When erect the cavity is filled with cement. When dry and hard, a very substantial foundation and support is obtained for the pole. Annoyances are experienced in regard to native labor. While the average Cuban is a better worker than the Filipino, he has his disadvantageous qualities. The natives eat a little bread and drink a little coffee in the morning. They expect to quit promptly at eleven o'clock for breakfast, just when you are getting interested in your work and want to keep on. The whole gang stops, and you cannot get a thing done until one o'clock. Then they work until six o'clock. The Cuban lineman is agile and willing. He can go up the poles well, and he can work if he wants to." It appears that some of the American soldiers in Cuba are already purchasing their discharges for the purpose of engaging in electrical work in the island. The planters are putting in more machinery. The electrical people are now placing orders for increased apparatus. More lights are being arranged for, and additional electric railway lines and the like are in progress. There is a better demand for electrically-operated machinery. Telegraph and telephone lines are being developed. There are without a doubt increased opportunities in Cuba for electrical manufacturers.

METHODS OF CREOSOTE ANALYSIS.

The growing scarcity of lumber, with the consequent high prices, is making it imperative that more attention be paid to preservative processes, whereby the time of service of timber may be lengthened. Coal-tar creosote is generally regarded as the most efficient of the wood preservatives. This product is very variable in composition, owing to differences in the coals used and in the methods employed in their distillation. Creosotes of different compositions are believed to have different values as wood preservatives, and an analysis of the oil used is, therefore, important.

No very large amount of study has been directed to perfecting the methods of creosote analysis, and the Forest Service, believing the matter vitally important to the progress of wood preservation, is now carrying on an investigation of these methods.

The most important part of a creosote analysis is the fractional distillation, since by this operation an approximate determination is made of the relative proportions of the most important substances in tar oil. There has been considerable divergence of opinion as to the best way of carrying out the fractionation of tar oils, some recommending a retort as a distilling vessel and certain temperatures for taking fractions, others recommending a distilling flask and a different set of temperatures.

Laboratory experiments, carried on by the Service, have shown that the difference in the weights of the fractions obtained when using different sorts of distilling vessels are not large, but that the composition of the fractions indicate a little better separation by the flask than by the retort. As regards the influence of the rate of distillation, variations of from one to three drops per second have but slight influence on the weights of the fractions, though the slower rate is more satisfactory.

It is commonly believed that the relative amounts of light oil, naphthalene, and anthracene oil are the most important factors determining the value of a creosote for wood preservation. A number of creosotes were very carefully fractioned and determinations made of the amounts of naphthalene and solid anthracene oil distilling between various temperatures. The average of the results shows that at least twenty-five per cent. of naphthalene was present in the distillate between 205 and 250 degrees C., and that over twenty-five per cent. of anthracene oil solids are present in the distillate above 300 degrees C. Work on the specific gravity and the index of refraction of the distillates between different temperatures is now being carried on.

The desirability of getting the criticisms and suggestions of users of creosote has led to the publication of a detailed account of the methods employed in the experiments and the results which have been obtained. Those who desire the publication should ask for Circular 80, Fractional Distillation of Coal Tar Creosote. Request should be made to the Forester, Forest Service, Washington, D. C.

UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION.

The annual meeting of the electrical committee of the Underwriters' National Electric Association will be held at the rooms of the New York Board of Fire Underwriters in New York, on March 27 and 28, for the purpose of making changes and additions to the national electric code. As is well known, it has always been the endeavor of the electrical committee to make only such changes in the code as are made necessary by progress in the art, or such as have been shown by some field experience to be necessary to safeguard against hazard, since changes in the code, even if necessary, cause more or less confusion and trouble. It will be remembered that at the last meeting of the electrical committee in December, 1905, there were submitted matters of such importance as to require further consideration before action was taken. These various matters were referred to sub-committees, by whom they were considered during the past year, and their reports will be considered by the full committee and finally brought before the general meeting in New York for action. The following committee reports will be considered: Committee on rules for signaling system; committee on slow-burning, weather-proof wire; committee on wiring and equipment of street railway property, including rolling stock; committee on double and single-pole switches; committee on variable-speed motors; committee on theater wiring; committee on construction and installation of rheostats; committee on series lamps; committee on insulating joints; committee on outlet boxes; committee on metal mouldings; committee on laboratory report in condulets; committee on rule 13A; committee on omitting fuses in neutral of three-wire systems, and committee on electric signs. There are also a number of suggested changes in the rules to be given consideration, as well as a number of miscellaneous suggestions.

WOMEN IN THE POSTAL SERVICE.

According to a report made by the United States postoffice department, Uncle Sam has 188 women assistant postmasters and 2,100 women employed as stamp, delivery window or money order clerks. The women clerks receive on an average $1,130 a year, or about $70 less than the men clerks. Two women employed in the postoffice department proper at Washington earn $1,800; sixteen receive $1,600; forty, $1,400; seventy-one, $1,200; and seventy-four, $1,000 per annum. A majority of these women are either wives or widows. The testimony of the postoffice authorities is that women make highly efficient public servants and that they are equal in honesty to men, if not superior to them.—"Weekly Bulletin."

TRANSFORMERS FOR MEASURING INSTRUMENTS.

Kenneth L. Curtis.

On looking over a large switchboard of modern design, one is at once struck by the uniform rows of measuring instruments. At first glance these instruments appear to be identical in every respect, and a close inspection shows that in external appearance they differ only in the lettering and figures on the scales. On examining the name plates we find that we have before us a variety of voltmeters, ammeters, wattmeters, powerfactor indicators, etc., and that the ranges of instruments of the same class vary from a few to many thousands of the units it is to measure. If we were to go farther and remove the cases from the instruments we would find that the similarity is not confined to them, and that the great majority of the instruments, the voltmeters and ammeters, are almost identical in all respects.

At some distance from these instruments are bus-bars and cables carrying currents of perhaps thousands of amperes at pressures of thousands of volts. Evidently these currents are too large to pass through the coils of any measuring instrument, and the pressures are higher than would be safe to apply to the leads of any instrument. In spite of these facts, the instruments on the switchboard indicate all of the electrical conditions of the cables and bus-bars in which we are practically interested. Although the greatest current flowing in any instrument lead is but a few amperes, we have an accurate indication of the voltages and currents and their phase positions of all of the circuits.

As is well known, all single quantity measuring instruments are inherently ammeters of very low range. In order that an instrument may measure pressures, the current flowing through its coil must vary directly with the voltage to be measured. The scale is then marked in volts. An instrument may be used to measure currents of any magnitude, provided the current actually passing through its coil is directly proportional to the current to be measured and the scale is marked accordingly. To indicate watts or powerfactors it is only necessary to combine current coils and pressure coils according to the usual construction of instruments for these purposes. A pressure coil is a coil carrying a small current whose magnitude is a measure of the pressure it represents. A current coil is a coil carrying a small current whose magnitude is a measure of the current it represents.

A pressure coil may receive its current through leads attached directly to the points between which the pressure is to be measured, provided the resistance of the coil is high enough to prevent too large a current flowing, and provided its inductance is low enough to prevent appreciable error due to difference in phase between the current and the pressure it represents. If the resistance of the coil itself is not large enough to fulfill the first requirement, a non-inductive resistance, called a multiplier, may be connected in series to keep the current within the range of the instrument. This arrangement is satisfactory for moderate voltages. At very high voltages it is not at all satisfactory, as the dangers attending the connection of instrument leads to the conductors of a high voltage system are obvious. In addition to the liability of the instrument being destroyed, there is the attending danger of injury to the switchboard attendants. The energy consumed at high voltages may also enter as a factor. The energy consumed by the instrument and its multiplier is proportional to the square of the voltage, and while very small at low voltages it would be by no means a negligible quantity at the high voltages now in common use.

A current coil may receive its current by attaching the leads to the terminals of a shunt resistance of low temperature coefficient, through which the current to be measured is flowing, provided the inductance of the coil does not introduce an appreciable error. This device also necessitates an electrical connection between the instrument coil and the conductors of the system with the attending dangers.

To avoid the dangers mentioned above, some means must be used that will give the desired result without necessitating an electrical connection between the instrument coils and the conductors of the system.

Fortunately the static transformer provides a means of producing in a secondary circuit at low current values and voltages an exact measure of what is taking place in the primary circuit. If the load on a transformer is very light, the secondary voltage per turn is almost identical with the voltage per turn in the primary, and the two windings may be separated from each other by any amount of insulating material desirable. Similarly the ampere turns of the secondary circuit are almost equal to those of the primary. Due to the resistance of the circuits, the leakage flux, and the necessary magnetizing current there will not be an absolute equality between the primary and secondary volts per turn, nor between the primary and secondary ampere turns, but the difference is small in either case, and may be compensated for by a change in the ratio of turns. Thus if a voltage ratio of 100:1 was desired and the ratio of turns of 100:1 should introduce an error of 1 per cent., the transformer should be wound with a ratio of turns of 99:1. To get a desired ratio of primary and secondary currents a similar change in the ratio of turns is made. The secondary ampere-turns are less than the primary ampere-turns, due to the magnetizing current in the latter. To get a given current in the secondary circuit, less turns are wound on the secondary coil than indicated by the rated ratio.

In alternating current practice the current and potential coils of the switch board instruments are used in conjunction with static transformers called current transformers and potential transformers. These transformers will be taken up and described separately.

Potential Transformers.

A potential transformer serves two purposes. It transforms the actual line pressure to a pressure within the range of the instrument employed. It serves to insulate the instrument from the line on which it is used. It closely resembles the familiar type of constant potential power transformer except in the case or mounting, and everything that enters into the design of the power transformer applies to the potential transformer. To prevent errors due to poor regulation the potential transformer is always large for its actual load, and hence cooling devices are unnecessary. As it is always located in a protected place, the enclosing case is noticeably light in construction. The iron, copper, and insulating material are arranged exactly as they would be in a power transformer of low capacity. As the total power taken by the potential transformer is very small, the efficiency is a secondary consideration. The chief point in the design is that of regulation. As stated before, a slight voltage drop may be compensated for by a change in the ratio of turns, but this is accurate for only one value of secondary resistance or load. Thus if a transformer of poor regulation gave the desired ratio when supplying the potential coils of three or four instruments, it would give too high a voltage if used on one instrument alone. For this reason the resistance and reactance of both the primary and secondary windings must be kept as low as possible. In using a potential transformer on the potential coil of a wattmeter it is necessary that the secondary current shall represent the phase position of the line voltage as well as its magnitude. This condition is never absolutely obtained under practical working conditions. The secondary current always leads with respect to the desired position, but the error thus introduced is so small as to be negligible.

The exact behavior of the potential transformer can be determined under any condition by applying the general theory of the alternating current transformer, which is too

well known to need reviewing here.* An idea of the magnitude of the quantities involved may be assisted by the following facts: In a well designed transformer on open circuit the secondary volts per turn are less than one-half of one per cent lower than the primary volts per turn. If the transformer is large enough so that the load furnished by the potential coils it supplies may be neglected its ratio will differ from the ratio of turns by less than one-half of one per cent. The current taken by each indicating instrument is about .04 ampere at a power factor so near unity that the wattless component may be neglected. Under ordinary working conditions the voltage to be measured will vary but a few per cent from the normal voltage of the system, and if the ratio of turns is adjusted to give the desired ratio at the normal voltage no appreciable error will be introduced at the greatest deviation from this value.

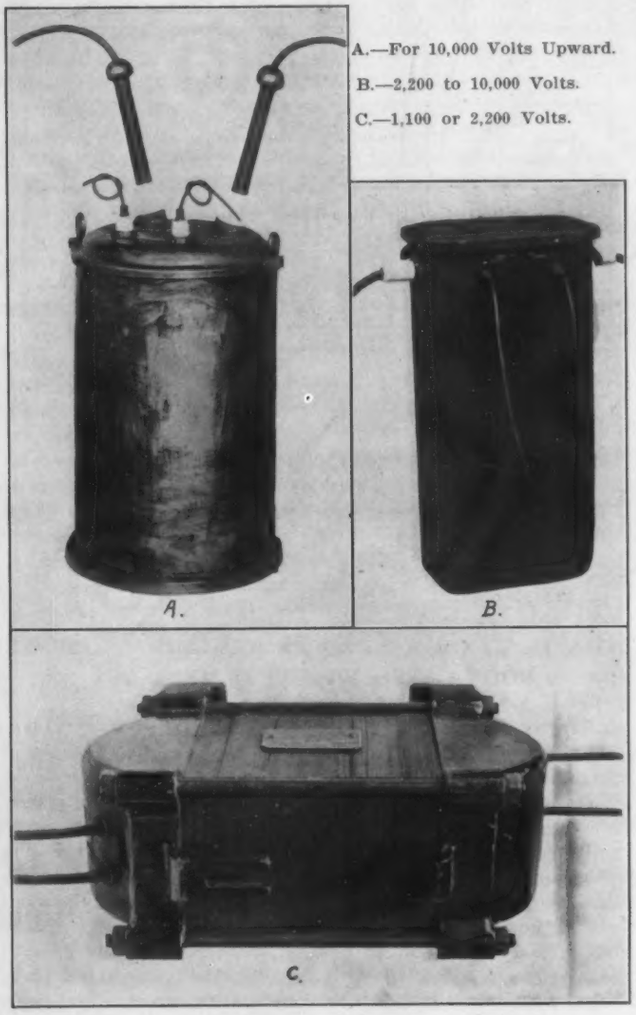


FIG. 1.

The general appearance of potential transformers is shown in Fig. 1. The oil insulated types closely resemble power transformers.

Current Transformers.

A current transformer performs the same function with regard to current coils of measuring instruments that the potential transformer does with regard to potential coils. It transforms the current to a value suitable to the instrument, and at the same time insulates the instrument from the line. Like the potential transformer it has two windings surrounding an iron core, but beyond this it resembles the potential transformer neither in appearance nor design. As the entire line current flows through the primary winding, sufficient copper must be provided in this winding for the purpose, and the large primary terminals are the predominating feature in the appearance of the current transformer. Fig. 2 illustrates several types of current transformers. In its design it is not necessary to consider the primary resistance or reactance, as the accuracy of the transformer is in no way affected by the magnitude of these quantities. The secondary or instrument current depends only on the ampere-turns supplied by the primary winding which will have the same

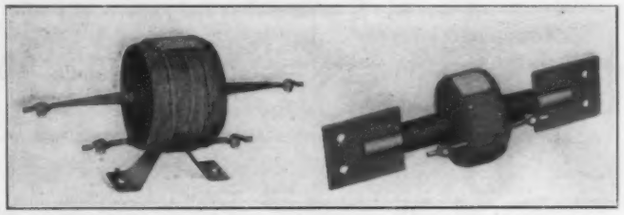


FIG. 2.

value regardless of the resistance or reactance of this winding. This fact is made use of in the location of the secondary winding and insulating material. To keep the secondary reactance as low as possible the secondary winding is placed next to the core. On top of this winding is placed the insulating material to protect the instrument from the line. This brings the primary winding some distance from the core and causes a comparatively high value of the primary reactance, which, as we have seen, has no bad effect. The secondary ampere-turns are less than the primary ampere-turns, due to the magnetizing current. The smaller the exciting ampere-turns in proportion to the total ampere-turns the more nearly accurate the transformer for all loads. This means that there must be plenty of iron in the core, and that it must be of good quality and well laminated. Under normal working conditions the values of flux density and the attending core heating are very low. If the instrument circuit should be opened when the primary is carrying current the active ampere-turns rise to the full primary value and the flux density and core heating rise to many times the normal working values. For this reason it is desirable that the secondary terminals of the transformer should be joined by a wire of low resistance when the instrument is removed from the circuit. In the earlier forms of current transformers a failure to take this precaution almost invariably resulted in the destuction of the transformer.

*The factors which enter the discussion of the current transformer are shown in the diagram, Fig. 3.

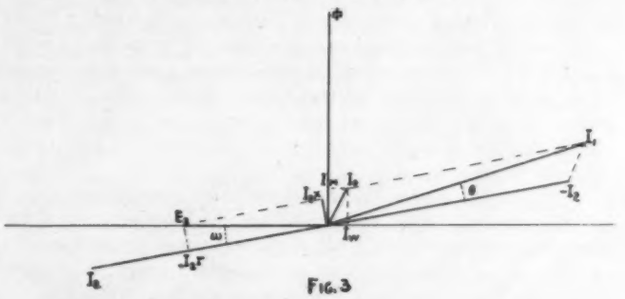


FIG. 3

1_2 is the secondary current.

r and x are the resistance and reactance of the secondary circuit.

*See "The Alternating Current Transformer," F. G. Baum. "The Elements of Electrical Engineering," C. P. Steinmetz.

*Curtis, "The Current Transformer." Proceedings A I. E. E., October, '06.

$E_2 = I_2 r + j\, I_2 x$ is the voltage generated in the secondary circuit.

ϕ is the total flux of the transformer. It is proportional to E_2 and is 90° ahead of E_2.

I_1 is the exciting current consisting of the wattless component I_M and the power component Iw.

$I_2 = I_0 + I_2$ is the total primary current.

ω is the angle between the secondary e. m. f. and current.

$$\cos w = \frac{r}{\sqrt{r_2 + x_2}} \qquad \sin w = \frac{x}{\sqrt{r^2 + x^2}}$$

k=ratio of transformer, is the factor by which the instrument reading (I_2) must be multiplied to give the primary current.

For ammeters $k = \frac{I_1}{I_2}$

For wattmeters the ratio is nearly $\frac{I_1}{I_2}$ but is influenced by the angle θ. The exact effect of the angle θ depends on the power factor of the load measured. If the power factor is $\cos\frac{\theta}{2}$ lagging current, it is evident that the wattmeter and ammeter ratios of the transformers will be the same. For the effect of the angle θ will be to cause the meter current to lead the line e. m. f. by $\frac{\theta}{2}$ thereby giving the same reading as though it lagged by the same amount. For lagging current power factors of less than $\cos\frac{\theta}{2}$, the wattmeter ratio will be less than the ammeter ratio, and for all other values it will be greater.

Given r, x, I_0, and I_2 to determine I_1 and θ.

The power components and wattless components of I_1 can easily be obtained from Fig. 3, as follows:

	POWER COMPONENT	WATTLESS COMPONENT
$-I_2$	$I_1 \cos w$	$I_2 \sin w$
I_M		I_M
Iw	Iw	
$I_1 = I_0 + I_2$	$I_2 \cos w + Iw$	$I_2 \sin w + I_M$

$$I_1 = \sqrt{(I_2 \cos w + Iw)^2 + (I_2 \sin + I_M)^2}$$

$$\cos\theta = \frac{I_2 + I_M \sin w + Iw \cos w}{I_1}$$

The curves in Fig. 4 were plotted from the above formulas for a standard three-ampere current transformer. Curve 1 shows the effect of resistance alone on the ratio. Curves 2 and 3 are for actual working conditions of the transformer when used on the coils of measuring instruments. Curve 4 shows the effect of a large inductance on the ratio. Such a high reactance is found only in the coils of relays for circuit opening devices, etc.

Current transformers and potential transformers are made in various sizes depending on the number of instruments they are to supply. All of the electrical conditions of a circuit can be told from the voltage and current and their phase relation. On the circuit there may be a voltmeter, an ammeter, an indicating wattmeter, an integrating wattmeter, and perhaps a power factor indicator, a frequency meter, and a connection to a synchronizer. One potential transformer may supply all of the potential coils, and one current transformer all of the current coils of these instruments, provided the transformers are of sufficient capacity. Transformers for

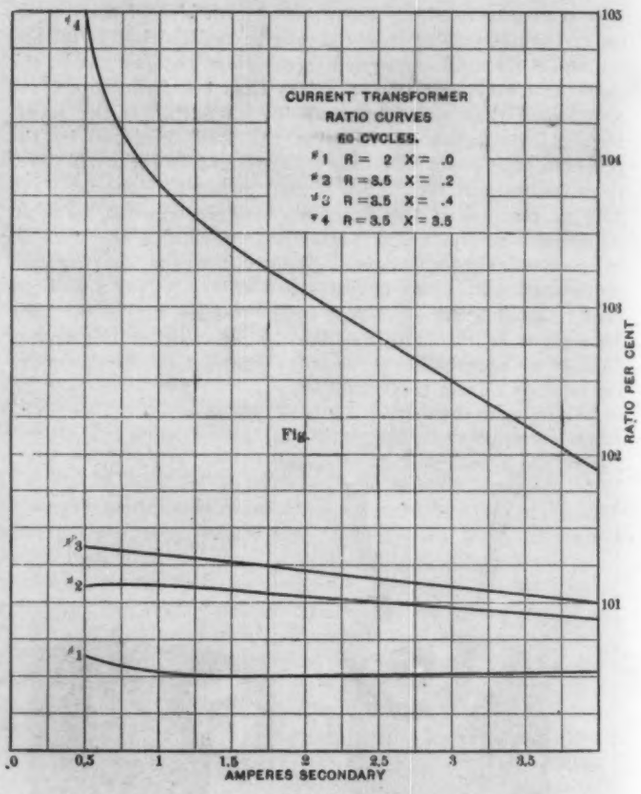


FIG. 4.

supplying the coils of relays are similar to the above in all respects. Owing to the high inductance of relay coils it is desirable that measuring instruments should in all cases be used on separate transformers.

THE LEAD OF A LEAD PENCIL AND A COPPER ROOF CATCH WIRELESS MESSAGES.

According to the "Cleveland Enquirer," Father Odenbach, head of St. Ignatius College, Cleveland, has discovered a method whereby he can intercept wireless telegraph messages by means of the copper roof on the college, some steel pins and the lead of an ordinary pencil.

While listening to the sounder connected with the ceronograph on the top of the college, by which lightning is recorded, Father Odenbach, who had substituted the lead pencil and pins for the usual expensive coherer in the instrument, heard the sounder tick off some Morse code characters. Investigation showed that he had intercepted messages received at the Clarke Wireless Telegraph Company's station, Cleveland, which came from the Detroit office.

At first the scientist did not understand the message, but he studied the code and finally was able to detect a few letters. Later he called in a telegraph operator, and the latter was able to take the message. It was found that the copper roof of the college, on which are stationed several weather recording machines, was a much better receiver than the poles and wires used at the regular wireless station.

The lightning recording instrument is so arranged that the sounder in the laboratory connected with the machine on the roof ticks when lightning flashes. It was through this machine that wireless messages were obtained. The regular stations use coherers that are very expensive and need constant attention, and Father Odenbach's discovery of the lead pencil-pin method is deemed important.

GROUNDED NEUTRALS OF STAR-CONNECTED ALTERNATORS.

This is a subject which has been causing a great deal of trouble to electrical engineers, both in this country and abroad. It has been found that if two star-connected alternators, with their neutrals earthed, are running in parallel, a large earth current may frequently flow between the two neutral points of the machines. The cause of this has sometimes been ascribed to dis-symmetry of the phases, and by changing over the windings of the stator this current has in some cases been reduced. Mr. E. P. Hollis, in a paper entitled "Points in Power Station Design and Operation," read before the Newcastle Local Section, touched upon the question, and expressed the opinion that a good deal of the trouble was due to the third harmonics of the wave forms of the machines. It is well known that at the neutral point of the star connection the third harmonics of the wave form (if they are present) give an alternating potential at three times the normal frequency of the alternator. These harmonics may give rise to capacity currents in the sheaths of the lead-covered cable, and the earth currents have often been attributed to this cause. Mr. Hollis thought that these were earth currents flowing between the generators, due to one generator having a third harmonic of greater value than the other, and thus a few volts gave rise to large currents flowing across the low earth resistance. His contention is supported by the fact that if only one generator neutral point is earthed, these earth currents are greatly, though, of course, not completely, reduced. It has often been noticed that if there are two similar circuits in parallel and conveying large currents, and one of these circuits be broken, a very little flash is obtained, because there is an alternative circuit for the current. By breaking the second circuit a large and brilliant spark is obtained. Now to apply this: Supposing there are two machines running in parallel with their star points earthed, if the currents noted were capacity currents, then on breaking one earth circuit one would not get a flash, as there would be an alternative circuit for the current—that is, up the other generator neutral point earth connection. But if the current is flowing between the two machines, then there will be no alternative circuit, and on opening the first switch one should get a flash; and all those who have open earth connection switches know that a brilliant flash is generally obtained, though, when at least three machines are running with their star points earthed, it may be obtained sometimes with one of two similar machines and not with the other. These earth currents are found to be of triple frequency when an oscillograph is put in the earth circuit. The conclusion arrived at by Mr. Hollis is that earth currents are flowing between the machines, and not between the machines, and the cable sheaths, and he asked: "Would it not, therefore, be advisable to insert in the earth circuit (when more than one machine neutral point is earthed), instead of the usual low resistance, an equivalent reactance? This would have the same effect as the resistance on all short-circuit and other currents of the ordinary frequency, but would have a triple impedance for the third harmonics' currents, and would tend to damp them down."

A SIMPLE LIGHTNING PROTECTOR.

In the protection of telephone cables an idea that may be valuable needs investigation. It was found from eleven years' experience in the installation of aerial cables that if a single loop two feet in diameter was made in the end of the cable, or even a "goose neck" of three or four feet in length, that in case lightning should puncture the cable, one need never look for trouble beyond this loop; that lightning coming into the cable from an overhead line would encounter such impedance at this point that it would jump the conductors and go to the cable sheath every time.

STEAM TURBINES AT COLLIERIES.

Sydney F. Walker.

The steam turbine is steadily making its way for colliery power plants. I believe that its first introduction in colliery work was at Ackton Hall colliery, in Yorkshire, in 1895. It belonged since, about 1890, to the late Lord Masham, who acquired it after it had been practically derelict for some time, previous owners not having been able to make it pay. The engineer who laid out the mechanical and electrical portion of the colliery, was a skilled electrician, and he had practically carte blanche from his owner. Lord Masham himself had naturally a very high appreciation of new inventions. He had realized a very large fortune by successive inventions in dealing with silk, and consequently his engineer had instructions to employ any apparatus, at any reasonable cost, that promised efficient working and economy. The engineer in question, who is now the manager of the concern, having succeeded his father in that post, told me that when he put down the first turbo generator, he did so mainly because the cost of the turbine and its dynamo was less than the cost of a reciprocating engine only, for the same work. The first turbine was succeeded by a second, and later by a three phase turbo generator, and I gather that the omnium gatherum of other electrical generating plants in use at the colliery, has been swept away in favor of turbines for the whole requirement. It used to be a very interesting sight at the colliery to see the different apparatus that had been laid down, as electrical engineering had developed. Space is not often of importance on the surface at a colliery, but the cost of buildings is, and the space occupied by a number of turbo generating plants, is so much less than that occupied by a number of reciprocating engine driven plants, that the cost of the building to house them is considerably reduced. The old question comes in again, of course, of the space required for the condensing plant, but very few collieries use condensing apparatus. Collieries seem to be divided roughly into two groups, those in which there is very little water indeed in the mine, and those in which there is a great deal. In both, however, it is not easy to obtain water for condensing, in a great many instances. It either has to be pumped from a distance, or a cooling tower has to be established. Water softening plants are becoming a necessity, even for boilers, while one of the very greatest necessities of colliery working is simplicity. The fewer apparatus there is about a colliery, and the simpler the arrangements, the better.

I notice, also, that Denaby Main, another of the leading collieries of Yorkshire, has also adopted turbines. Denaby has employed electricity very largely, almost from the time when it became practical, and it has spent a very large sum in doing so, with resulting economy in working. It was at Denaby that the test was made of the quantity of steam condensed in the steam pipes supplying an endless rope haulage plant underground. The pipe was stopped at the in-bye end, a steam gauge fitted there, and the pressure maintained at a figure that was required to work the haulage engine. It took, if I remember correctly, two large Lancashire boilers, to keep the steam at the pressure named, merely making good the losses by condensation. After a three phase plant had been put down, and the haulage plant was worked by three phase motors from it, the same two boilers furnished sufficient steam to drive the plant, setting free the other boilers that had been required to keep the steam going, apart from condensation.

Incidentally, it may be remarked, that the scarcity of water in most mining districts, suitable for boiler feed and for condensing, tends very strongly in favor of the gas producing plant, since the quantity of boiler water required is so very much smaller, and the water employed in the scrubber may be almost anything you like.

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Entered as "The Electrical Journal," July, 1895.
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VOL. XVIII MARCH 16, 1907 No. 11

EDITORIAL.

Distribution from the Sub-Station

Along with the many advantages possessed by alternating current for general electric light and power service, it must be admitted that its almost universal adoption for the generation and transmission of electrical energy has introduced many intricate details in the distribution of electric power from the sub-station. The delivery of energy to the service leads of the many customers, with their widely-varying requirements, necessarily requires a complicated equipment and system, not only of apparatus, but of mains, feeders and transformers. From the same station, as is set forth in the description of the Oakland Gas. Light and Heat Company's plants, which is to be found elsewhere in this issue of the "Journal," there is required direct current at 500 to 600 volts for street railway service, and also direct current at the same voltage, or 440 and 220 volts, three wires for elevator and similar motors. Alternating current, both single-phase and polyphase, at voltages from 2,000 to 10,000, and also constant current alternating service for the series enclosed arc lights for municipal and commercial purposes, covers, in most cases, the necessary alternating-current supply.

When compared with the old constant-potential, direct-current stations, the cost of the plant per kilowatt capacity is greatly increased when electrical energy in so many forms is required for light and power. Considering the generation of power, alternating-current machines usually have a higher efficiency than direct-current machines. However, with the numerous transformations and necessary sub-stations, even with large units and the very best apparatus, it is probable that the total efficiency of the modern electric light and power systems is not greater than the old direct-current stations. The large area which is supplied from one point, however, and the availability and flexibility of the service from the modern station makes it more satisfactory than its direct-current predecessor.

Between the customer and the generating station there is interposed in the modern plants many devices which may cause interruption of service, but the size of electric light and power stations at the present time has increased to such an extent that duplicate apparatus is almost invariably available. Therefore, while the number of links in the chain between the generating station and its customers has been greatly increased in modern plants, a corresponding increase has been made in the equipment. From the customer's standpoint, therefore, the service should be as reliable as that of the old direct-current plant. As a matter of fact, however, the regulation of voltage or pressure in many modern plants is not as good as was the case in the old, and now practically discarded, direct-current stations. For electric railway service and variable-speed motors, direct current will probably always be used to a very great extent, notwithstanding the very great improvement in alternating-current motors for both classes of service. For improving the load factor, however, as yet nothing has been suggested or perfected to take the place of the direct-current storage battery, and where the demand for power is subject to wide variation, either during very short intervals or over twenty-four-hour periods, the storage battery will probably retain, and even increase, its present position in improving the all-day efficiency of both the generating and sub-station plants.

For almost all electro-chemical purposes, direct current is a necessity, and while alternating-current motors for widely-varying loads and speeds, and also for electric traction, may be made to replace the present direct-current machines, in all probability, due to the advantage of the storage battery in improving the load factor, direct current will continue to be a large part of the required service from electric light and power systems.

ALCOHOL MANUFACTURE IN GERMANY.

Germany leads to-day in the manufacture and use of alcohol for light and power. In that country potatoes are the chief source from which alcohol is produced. The potato crop last year reached the astounding proportions of 1,775,579,000 bushels, or more than 53,000,000 standard tons. Of this amount nearly one-half was used in the manufacture of alcohol and starch. One-eighth of all the tillable land in Germany is planted to potatoes, which show an average production of 217 bushels an acre, which sold at an average of 27.6 cents a bushel, or about $60 an acre. In France alcohol for manufacturing purposes is made chiefly from molasses and sugar beets.

BOOK REVIEW.

Concrete Factories.—An illustrated review of the principles of construction of reinforced concrete buildings, including reports of the Sub-Committee on Tests, the U. S. Geological Survey, and the French Rules on Reinforced Concrete. Compiled by Robert W. Lesley, Associate Am. Soc. C. E. Published for the Cement Age Company, by Bruce & Banning, New York.

Reinforced concrete in building construction has already proven its adaptability, and constructing engineers all over the world are using it extensively in every branch of engineering work.

For this reason the importance of determining by a series of exhaustive tests, scientific formulae for its use has resulted in the creation of a Joint Committee on Concrete and Reinforced Concrete, the members of which are representatives of all the leading engineering societies.

The scope of the work to be done, explanation of the field to be covered, and an outline of tests to be made is shown in Reports of the Sub-Committee on Tests made to the Joint Committee. This is published in full, together with a complete report governing the use of reinforced concrete in France.

These reports, with an article by Mr. Grumby on Surface Finish for Concrete, and some views of leading engineers and architects on this subject as a conclusion, complete the matter in the books. It will be of value to every engineer.

"The Use of Alcohol and Gasoline in Farm Engines," published by the U. S. Department of Agriculture, being Farmers' Bulletin No. 277. By Chas. Edward Luche, M.S., Ph.D., assistant professor of mechanical engineering, Columbia University, and S. M. Woodward, M.S., M.A., irrigation engineer, office of experiment stations.

TRADE CATALOGUES.

G. E. Witt Co.—Catalogue No. 6, devoted to Little Giant Crude Oil Burners, Pump Governors, Reducing Valves, etc. 1165 Howard Street, San Francisco.

"Brills Magazine," published in the interests of the J. G. Brill Co., Philadelphia; American Car Co., St. Louis; G. C. Kuhlman Co., Cleveland, and The John Stephenson Co., Elizabeth, presents special features of semi-convertible cars for Boston, in a very attractive manner.

The Wellman-Seaver-Morgan Company.—A neat, well-illustrated circular on the Hughes continuous gas producers, has just been issued by this company. Description of producer is given, with cuts and diagrams showing clearly its construction. A number of illustrations of plants already equipped with this appliance are also shown. Applications for this catalogue should be sent to the above company, at Cleveland, Ohio.

The Mutual Gas and Engineering Co. have sent out a folder descriptive of "The Foveaux Fluid Controller." This device is a combination valve and pipe fitting, and will interest all engineers, boards of public works, fire insurance companies, and others interested in the safe and economical distribution of gas, water and other fluids through public streets. Address all requests for copies to the above company, at 801 Union Savings Bank Building, Oakland, California.

Westinghouse Electric & Manufacturing Co.—This company have just issued the following circulars:

No. 1131.—Westinghouse Graphic Recording Meters, illustrated, showing the various types and their construction.

Folder No. 4074.—Oil Circuit Breakers, Types B, F and J, for Potentials from 3,300 to 22,000 volts.

Folder No. 4070.—Type E Oil Circuit Breakers, Hand Operated, Distant Control.

Folder No. 4073.—Type G and L, Oil Circuit Breakers, 60,000 volts, 100 amperes.

Westinghouse Oil Switches, Types D and J.

The Holtzer-Cabot Electric Co.—Bulletin No. 303A, replacing No. 303 on special elevator motors, with cuts and data regarding same.

Form No. 1028.—Lineman's "Receiver Type" Testing Set.

Form No. 1025—Universal Lineman's Testing Set.

Form No. 1024.—A Water-Tight Telephone.

Circular No. 205A.—The Flexiphone; a combination desk telephone instrument and adjustable arm.

Bulletin No. 310A, displacing No. 310.—Magneto Power Generators.

PERSONAL.

Mr. E. L. McKie is now at the head of the sales department of machine tools for Herron, Ricard & McCone, 436 Market Street.

OAKLAND HARBOR IMPROVEMENT.

The San Francisco, Oakland & San Jose Railroad Company (Key Route) has started the work of constructing the new harbor basin on the water front, south of its present pier, and the work is to be pushed rapidly. A large dredger at the foot of B Street will go to work at once dredging out the space lying between the tracks of the Key Route and the Southern Pacific mole. It is thought that in making a channel to the wharves which will be built along the sides of this basin to a depth of thirty feet, sufficient material will be secured to fill in the 500 acres of land owned by the company along the north side of the basin. The amount of material to be dredged to give the channel a uniform depth of thirty feet will be 5,000,000 cubic yards, and this amount will cover the filled land to a depth requisite for its usage. This filled land will be utilized for sites for railroad terminals and for manufactories. A track will be extended from the wharves which abut on this filled ground to the proposed branch of the company on Wood Street, which will give the company an outlet in that direction, and will give it further connections with such railroad lines which may be seeking the water front for terminal facilities. The work of dredging out the channel and the construction of the new wharves, which will give accommodations for fully 200 vessels of the largest size, will be under the supervision of Howard Holmes, the well-known engineer.

AN INTERESTING EXPERIMENT.

Professors Joseph Le Conte and Noble, of the Department of Electrical Engineering of the University of California, having found it impossible to obtain any satisfactory data on the windage loss of a revolving element, are conducting some interesting experiments in this connection at the University.

The apparatus consists of an iron pulley wheel of large diameter to which wooden blocks of the same shape and size of the field coils of a revolving field-type generator are attached. This is surrounded by a stationary wooden ring built up in the form of the stationary windings of the armature. With this arrangement it is hoped to determine a definite relation between the windage, or air losses of a generator and the speed of rotation.

INDUSTRIAL

A NEW HIGH PRESSURE BLOWER.

A Rotary Blower with Two Stationary and Two Rotating Parts.

To its large variety of centrifugal or fan blowers, the B. F. Sturtevant Co. has added a blower of the positive or rotary type, Fig. 1. Built for pressures up to 10 pounds a square inch it is suited for cupola work, smelting, hardening and annealing furnaces, pneumatic tube systems, etc. The same design is successfully used for handling air or gas on an exhauster, the stuffing boxes preventing leakage at the points where the shafts pass through the end plates.

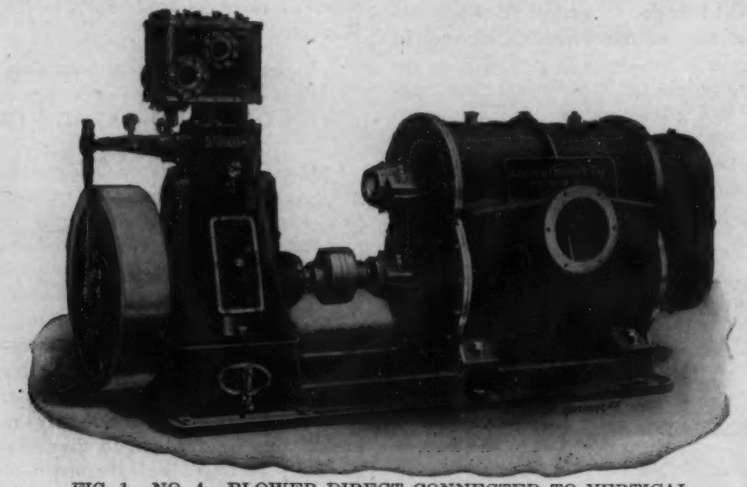


FIG. 1. NO. 4. BLOWER DIRECT CONNECTED TO VERTICAL ENGINE.

Features that make this blower different from others of the positive type are the ample clearances, which render unnecessary elaborate adjustments of journal boxes, and the absence of work done by one of the rotors, thereby reducing the power transmitted by the gears to an amount necessary to overcome the friction of the journals. The practically constant power thus transmitted admits of the use of the same gears for all pressures.

FIG. 3. THE IMPELLER.

Construction of Blower.

The blower consists of but four principal parts—two stationary and two rotary. The symmetrical casing or shell is of cast iron provided with end plates or covers which support the chain-oiling bearings and make an air-tight housing. On either side of the casing are intake and discharge openings, flanged, drilled, and tapped for standard gas-pipe fittings. The other stationary part seen in Fig. 2, a cylindrical core projecting inward from the end plates that support the impeller shaft, forms with the casing an annular space in which the impeller blades turn.

One of the rotors, the impeller shown in Fig. 3, does the entire work of compressing and moving the air or gas. Consisting of three diamond-shaped bars or blades, it successively forms within the annular space three pockets in which the air is imprisoned and carried around to the discharge. The volume of each pocket is decreased as it nears the discharge, and consequently it delivers air at greater density.

The second rotor, Fig. 4, called the idler because it does no work, revolves at the same speed as the impeller to which it is connected by spur gears, the shafts upon which the rotors are mounted being parallel. The function of the idler is to allow the impeller to return to the suction side without loss of compressed air. This is accomplished by having the blades of the idler of such shape and size that they always cover the opening.

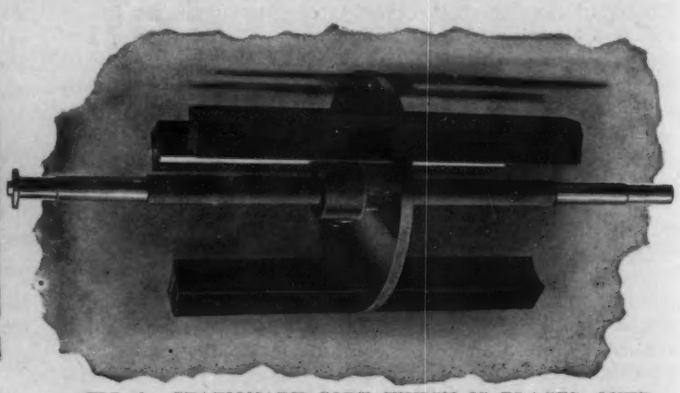


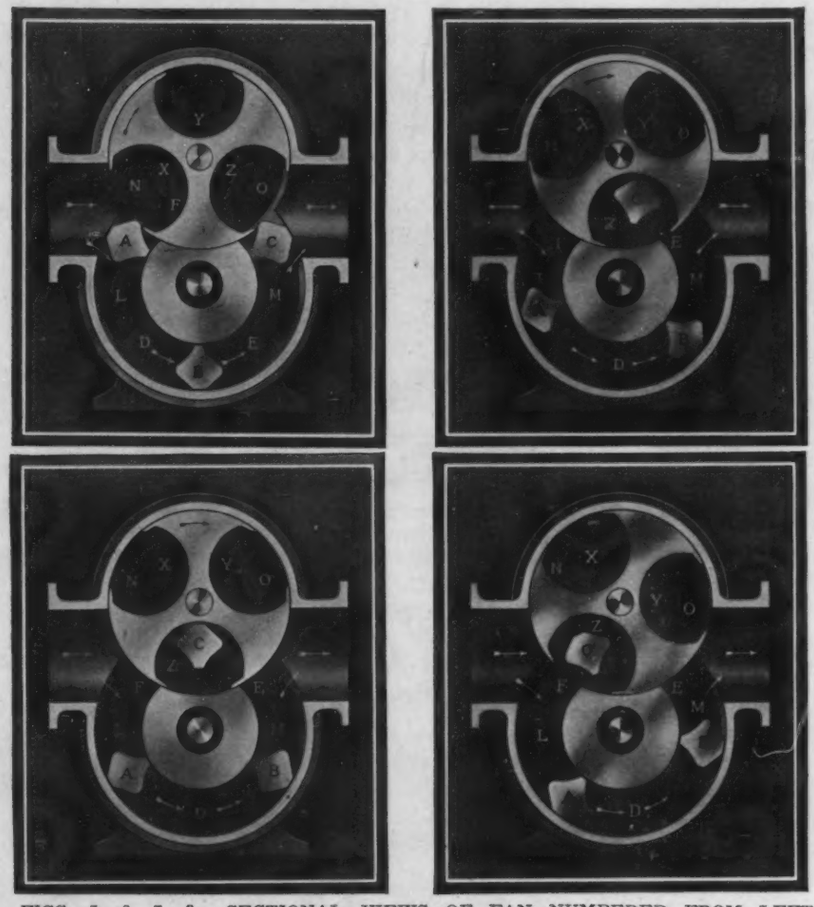
FIG. 2. STATIONARY CORE WHICH IS PLACED OVER IMPELLER SHAFT.

Ample clearance between the rotors is provided for in the design, one-eighth inch in small sizes and one-half to three-fourths inch in large sizes representing the distance. This is sufficient to insure safe operation even with considerable var-

iation in the running of the gears. The clearance between the rotors and the casing, while not as great as between rotors, is sufficient to prevent contact. The effect of clearance is intentionally increased by passages formed in the end plates, the function of which is taken up in connection with the explanation of operation.

Operation.

Air or gas at atmospheric or suction pressure entering the blower at the intake is successively imprisoned in the three pockets formed by the three blades of the revolving impeller, and, since these volumes are reduced as the impeller blades pass into the idler spaces, the air is discharged at any desired pressure up to ten pounds a square inch. The volume of free air displaced each revolution is constant, the pressure varying with the speed and with the resistance to the passage of air.



FIGS. 5, 6, 7, 8. SECTIONAL VIEWS OF FAN NUMBERED FROM LEFT TO RIGHT AND SHOWING ROTATING PARTS AND STATIONARY CORE IN DIFFERENT RELATIVE POSITIONS.

The principle upon which the blower operates is clearly shown in Figs. 5, 6, 7 and 8, which are sectional views illustrating four successive stages in the movement of the rotors. In the explanation it is assumed that the blower is running at a speed to produce average pressure, and that this pressure exists in the discharge outlet.

While the rotating members are advancing to the positions shown in Fig. 5, air enters and completely fills space X and chamber D, while pockets E and Z are discharging air against the pressure in the delivery pipe. From the previous movement of the rotors, the pressure in Y, filled with air carried over by the revolving idler, has been increased slightly by air flowing through the leakage passage N. The space between blades A and C, just above the concave portion of the core, is practically filled by the wing of the idler, and consequently it takes no part in the action. Space Z is about ready to receive impeller blade C and pass it to the suction side.

While revolving from the position shown in Fig. 5 to that shown in Fig. 6, the air in pocket D has been carried along, and free communication between chamber D and the inlet has been cut off. If, however, the speed was such as to prevent D becoming filled to atmospheric pressure, the leakage passage L allows the flow to continue; but this effect is very slight. Space Z is filled with air under pressure, which further movement will carry toward the suction side where it would flow back to the inlet and in escaping, cause noise. But this loss and noise is lessened by the leakage chamber O, which allows the pressure to be transmitted to the air in space Y, thereby still further increasing its density. Leakage back to the suction side is prevented by the wing of the idler.

Continued rotation carries the rotors to the positions shown in Fig 7; atmospheric air is now entering pocket F, the air in D is being carried around between blades A and B in the annular space, and E is discharging. Impeller blade C is moving toward the suction side in the space Z. Above the impeller the remaining pressure in Z is being transmitted to the air in X by means of the leakage passage N provided for the purpose, thereby making its pressure a little greater than atmospheric. The air in space Y under slight pressure from previous leakage is imprisoned, and being carried around by the idler.

When the fourth position is reached, pocket F will be filling, the pressure in chamber Z will have been reduced nearly to atmospheric by leakage, space Y will discharge, and a little compressed air from the delivery pipe will flow back through leakage passage M and increase the pressure in D, which will result in a quieter discharge taking place when further movement brings B into the discharge passage.

The purpose and advantage of the leakage chambers is now apparent; they make it possible to recover the pressure which otherwise would escape from the impeller pockets and by making the increase in pressure gradual cause the blower to run with less noise. Leakage passage L has practically no effect when the blower runs at ordinary speed and in the direction shown here; it is provided to make the blower symmetrical, thus allowing it to run in either direction.

It will be noticed that the impeller carries three blades, set at equal distances around the periphery, thus causing three admissions of air at each revolution.

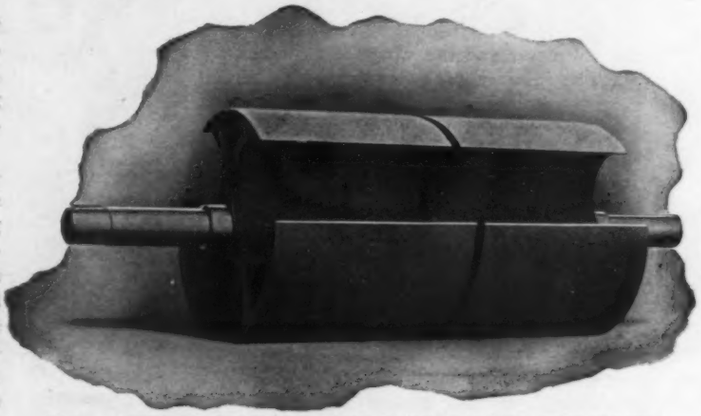


FIG. 4. THE SECOND ROTATING PART, CALLED THE IDLER.

COMBINATION PORTABLE WATTMETER.

The Wagner Electric Manufacturing Co. is introducing a portable instrument which has such a multiplicity of uses that we believe central station managers and manufacturers will find it of great value, both in the introduction of their goods to the general public and in testing lamps and accessories used by their new business departments in the campaign for business.

The instrument carries a lamp socket imbedded in the case, which socket extends, perhaps, one-eighth inch outside of the case, in which socket is placed the lamp or the attachment plug connected with the device under test.

Over to the right-hand side, as shown in the cut, is a little hard-rubber switch; this switch carries two pointers, one on each side. One of the pointers is marked 110 (or 150 volts, as the case may be), and the other pointer is marked 220 (or 300 volts, as the case may be). The instrument is designed in such a way as to be suitable for operation on both 150 and 300-volt circuits, by simply throwing the switch to the proper voltage point.

Each side of this switch, that is, the 150-volt side and 300-volt side, travels over an arc which has three stopping points: The first reading "volts," the second, "watts," and the third, "off."

While central station managers will find this instrument of great value in influencing their purchase of lamps and other current-consuming devices, the sale of which is being so generally pushed by the new business departments, they will also find it is of great value in their engineering department in the determination of core losses in small lighting and power transformers; this combination lamp-testing volt wattmeter is well adapted to this purpose.

Scales: This instrument has a double scale, a voltage scale reading, say, up to 150, and wattage scale reading up to 150 watts, there being one needle covering both scales. This needle is actuated by the voltage movement when the switch is on the point marked "volts," and is actuated by the wattage movement when the switch is on the point marked "watts." The instrument thus serves the double purpose of being a voltmeter and wattmeter combined.

When the switch is on the 300-volt side, the scale readings are to be multiplied by two, thus giving a range in both the voltmeter and the wattmeter movement, form 0 to 300.

The instrument, as ordinarily furnished, is put out in a neat, hard-maple carrying case, although, in addition to this, a leather carrying case with shoulder strap, is supplied at a small additional cost.

The multiplicity of uses to which this instrument can be put will appeal to engineers, as, in addition to the testing of lamps, it will be found very useful for the testing of small motors, water heaters, coffee percolators, etc.

In the purchase or sale of lamps, for instance, this instrument will prove very valuable. A lamp manufacturer or a manufacturer making small current-consuming devices and making good goods, can receive only benefit from it, as the use of this instrument by his salesman, in addition to showing up the good points of his own apparatus, serves to accentuate the deficiency of inferior types.

Cut No. 2186 shows the method of connecting the instrument and the transformer under test to the testing circuit. Great care should be taken that the primary or high voltage leads of the transformer are on open circuit and disconnected from all other circuits.

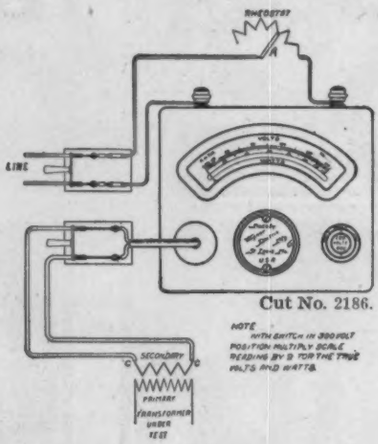
A rheostat or resistance is shown at "A," and is necessary for adjusting the voltage of the transformer terminals. This resistance should be of about 180 ohms, and of approximately two-ampere capacity. An ordinary field rheostat of about two-ampere capacity will be found convenient.

It is preferable, however, to adjust the voltage of the generator where this can be done, and it is usually possible to do this at time of light load. Owing to the low power factor of this test, care should be taken not to leave the current on the coil longer than necessary to take a reading.

The following iron loss measurements may be expected in transformers of recent manufacture, losses taken either on 110 or 220-volt, 60-cycle:

Trans. K. W. Cap.	Approx. Watts.
1 to 5	30 to 100
7½ to 15	100 to 200
15 to 30	200 to 300

Core loss tests which are to be used for comparative purposes, such as ageing tests, should be made under as nearly the same conditions as possible. The speed of the generator (or the frequency of the circuit) should always be the same, since the frequency will affect core loss readings. If possible, tests should be made when the load on the generator is light, as the nature and amount of the load may effect the readings considerably. These precautions apply only to core loss tests, and need not be observed in testing lamps.



Cut No. 2186.

The actual operation of the test is as follows:

Connect up the transformer and instrument in accordance with diagram, setting rheostat so voltage on the instrument when switch is placed on point marked volts, is the same as the rated secondary capacity of the instrument. That is, 110 or 220 volts. With switch on point marked watts, the instrument reading will be the actual iron loss of the transformer.

Quotations will be furnished to all interested parties writing to the factory or to district representative.

Los Angeles, Cal.—The California-Nevada Electric Power Co., with a capital stock of $10,000,000, of which $5,000 common has been subscribed, has filed articles of incorporation. The new company will manufacture and transmit electricity for the use of railroads, quarries, municipalities, and consumers in general. It also reserves the right to dispose of water and water rights and to do all things for which a corporation is formed. The stock has been divided into 5,000,000 preferred and 5,000,000 common. The directors are Rea E. Maynard, of Los Angeles, F. G. Baum, of Berkeley, F. V. Keesling, C. R. Lewis and O. K. Grau.

NEWS NOTES

ELECTRIC RAILWAYS.

Boise, Ida.—The Boise and Interurban Electric Ry. Co. announces that its line between this city and Caldwell will be in operation by May 1.

Loomis, Wash.—Don A. Dewey is here securing the right-of-way for the Okanogan Electric Ry. Co. in this valley.

Portland, Ore.—Work has been commenced grading for the Oregon Electric Co. in South Portland. Chief Engineer Donald has charge of the work.

Palouse, Wash.—The work of laying steel on the main line of the Spokane & Inland has been completed.

Tacoma, Wash.—Engineers in the employ of the Tacoma Ry. & Power Co. are making final surveys of the route between this city and Orting.

Tacoma, Wash.—The Tacoma Ry. & Power Co. has commenced laying a second track between Hosmer Junction and Pine Street. The company will also erect a new depot.

Victoria, B. C.—Work will be commenced next week on the construction of new car sheds for the B. C. Electric Ry. Co. on Discovery Street. A. T. Goward, manager.

Walla Walla, Wash.—Contractor Nicholas Wierk will begin work at once on the new car barn of the W. W. Valley Traction Co. at 13th and Cherry streets. The building will be a one-story brick 60x150 feet, with 20-foot ceiling.

Astoria, Ore.—Council granted a thirty-year franchise to S. D. Adair and E. B. McFarland for a street railway leading from Commercial Street to the county bridge at Young's Bay, where it is to connect with a railway running to Warrenton and New Astoria.

Burley, Ida.—W. D. Kenyon, who has geen granted a franchise with others to build an electric railway in Cassia County, advises that the company which will be organized will be known as the Idaho & Nevada R. R. Co. The line will extend from this place to Oakley, a distance of twenty-five miles.

Everett, Wash.—The Everett Railway & Electric Co. announces that it will extend its electric line to Silver Lake, a distance of five miles.

Portland, Ore.—The county commissioners granted a franchise for an electric railway line on the Sandy Road to extend from the intersection of the Sandy Road with East Sixteenth and East Davis streets in a northeasterly direction towards the Columbia River. It will be built and operated by the Portland Ry., Light & Power Co.

Rosalia, Wash.—The foundation is being laid for the sub-station of the Spokane & Inland at Rosalia. The building will be of brick and 60x60 feet. The Spokane & Inland will furnish power and light for Rosalia.

Spokane, Wash.—The Washington Water Power Co. increased its capital stock to $1,000,000. The increased capital will be used for extensions and betterments to the system.

Tacoma, Wash.—The Tacoma Ry. & Power Co. will build a loop at the end of the American Lake line.

Tekoa, Wash.—The Tekoa and St. Maries River Ry. Co., capital $500,000, has been incorporated by T. J. Mahoney, W. A. Mosier, T. H. Follett, E. C. Dowel and William Hoare. Principal object to construct a line of railway from Tekoa to a point on the St. Maries River in Idaho, a distance of fifty miles. Electricity will be the motive power.

FINANCIAL.

San Francisco, Cal.—One of the most important actions affecting financial interests yet taken by the Supervisors was that taken February 28th, when the Board declared forfeited to the City and County of San Francisco all the franchises of the Spring Valley Water Co. and the waterworks themselves. The action was taken by the Board because of the alleged violation of the law and the Constitution of California in charging a different water rate from that established by municipal authority. The formal resolution of the Board recites that the Constitution of the State of California expressly provides that any company collecting water rates otherwise than as established under the authority granted by the Constitution shall forfeit the franchises and waterworks of such company to the city and county where the same are collected. It further recites that the Spring Valley Water Co., through its duly accredited officials, in the recent water rate investigation, testified under oath that the company was still collecting rates in contravention of those established by the Board of Supervisors; and that, therefore, it is resolved that the Board of Supervisors declare "all franchises and waterworks of said Spring Valley Water Co. forfeited and escheated for the public use to the City and County of San Francisco."

Attorney Kellogg, of the company, says: "We are not going to lose any sleep over this action of the Supervisors. It's a joke. I don't know what move the Board will make, but we shall certainly fight the city in the courts to a finish in this matter. There is nothing for us to do just now. We shall await an attack. The company is not conscious of any wrong-doing, and we shall go ahead defending our rights. This resolution doesn't mean anything at all."

President Payson says: "This comes as a great and unexpected surprise to me, and I cannot express myself on the matter until I have consulted my attorneys. I can state that the Spring Valley will do all in its power to resist such action on the part of the Supervisors. This company will take the matter into court, and as far as the law will give remedy we shall take it. What we have done to break the law is not clear to us yet, but as soon as we are informed of the grounds on which the Supervisors based their action we shall be able to answer."

The basis of this disagreement seems to be that the company and the Supervisors disagree about the valuation of the plant. City Engineer Woodward has placed the value of the plant at $24,569,328, while the officials of the corporation desire to charge enough to get interest on $51,405,000, which they claim the property is worth. Included in the company's estimate is their idea of the value of prospects in Calaveras and Tuolumne counties, although the Spring Valley does not own any property or rights in Tuolumne County and has not developed its holdings in Calaveras County. Furthermore, President Payson claims that the company lost $800,000 by last April's disaster and has been since losing $20,000 a month.

Oakland, Cal.—The People's Water Co., through its attorney, M. C. Chapman, gave notice at the last meeting of the committee of the whole of the City Council that it would demand that the value of its Oakland plant for water purposes be assessed at $10,000,000. This is an increase of $3,000,000 over Judge Hart's valuation, and practically an increase of $5,000,000 over the valuation placed upon the plant last year by the City Council.

ILLUMINATION.

Compton, Cal.—The Compton Lighting & Power Company, recently incorporated with a capital stock of $50,000, will immediately begin preparations for the erection of a 6,000-light plant on Pomegranate Street, where the first unit will be installed. A franchise has already been purchased through G. R. Fulton.

Pasadena, Cal.—Bids for the latest addition to the building of the municipal electric light plant have been received and referred to the head of the department for his report. The plans call for the expenditure of about $50,000, and involve the tearing down of a portion of the old building.

Anaheim, Cal.—Remodeled plans for the new power house have been submitted by City Engineer Schenck. Bids for the construction of the building are to be opened March 14th. On the recommendation of Mr. Schenck all bids for new arc lights were held over pending an investigation of the results of the new flaming arc light now being tried in Los Angeles.

OIL.

Los Angeles, Cal.—Oil circles have a sensation in the alleged repudiation of the Associated Company of its immense contract to supply the Los Angeles Gas Co. It calls for 300,000 barrels annually, was made in 1904 and does not expire until 1910. The stipulated price is between forty cents and forty-five cents a barrel, delivered, not over half the rate now charged on contract. The gas corporation threatens suit for heavy damages unless a compromise is effected. The Associated bases its action on the ground that the gas company violated its contract by buying additional oil from other companies at a much higher price. The buying concern declares that this has no bearing on the Associated Company's contract. The latter's officers here absolutely refuse to discuss the affair, except to deny that their action is due, as other oil men believe, to the higher price and shortage of output. It is the opinion among oil men that the Associated has done right in refusing to deliver any more oil to the gas company, in view of the fact that the other has repeatedly broken its part of the contract. It is not likely that anything will come of the proposed suit.

Sisson, Cal.—Several of the large lumber companies of Northern California have concluded to use oil for fuel in their locomotives. It is known that a large proportion of the destruction wrought by fire in our forests has been occasioned by sparks from locomotives. While the companies have taken this action as a matter of self protection, the forestry department has a ruling that no company shall enter the reserves that uses fuel other than oil.

Los Angeles, Cal.—The Santa Monica Oil, Gas and Mining Company, a new company, owns 3,260 acres of land ten miles northeast of Santa Monica in the district said to be the best oil region of the State. Gold is also found on the land in some quantity. The work of developing the property will begin at once, and the promoters are enthusiastic over their holdings.

ENGINEERING.

Boise, Ida.—T. W. Thomas, secretary of the Big Lost River Land & Irrigation Co., stated that Engineer Darlington will be in charge of the construction work at Mackay. A canal thirty-six miles long will carry water from two large reservoirs, one four miles from Mackay and the other in Blaine.

Huntley, Mont.—Bids are asked by the U. S. Reclamation Service until April 7th for constructing structures on Garland Canal and laterals near Ralston, Shoshone project. The work involves about 47,000 cubic yards of grading, 5,000 cubic yards of concrete, placing 348,000 pounds of steel reinforcing bars and other incidental work.

Paterson, Wash.—The State Irrigation Co., capital $100,000, with C. W. Corliss, of Seattle, secretary, and Dr. C. W. Sharples, president, will install a pumping plant with a 250-horsepower boiler to furnish water for their desert land claims.

Salem, Ore.—The Josephine-Klamath Co. has been incorporated with a capital of $1,000,000, by F. William Russ, F. D. Smith and R. C. Maxwell. This company will engage in agricultural, mining and irrigation work in the counties of Josephine and Klamath.

Spokane, Wash.—Charles Swanson and associates, of this place, have purchased 300 acres of land on the Columbia in Lincoln and Douglass counties. They will install a model irrigation plant at a cost of $30,000.

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